SCHOOL SCIENCE AND MATHEMATICS

VOL. XXXVIII | OCTOBER, 1938 | WHOLE NO. 333

THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS CAN HELP YOU

Quite often teachers do not join an Association because they are not informed of its activities and purposes. This may be the fault of the Association in not furnishing the information, or it may be the carelessness of teachers in not attempting to acquire it.

I will list briefly the different activities in which the Association takes part and the materials it furnishes to its members. The **Central Association** was organized in 1903 and has had a continuous existence since that time. It has been the leader in improving the teaching of science and mathematics for thirty-five years.

The Association holds an annual convention each year on the Friday and Saturday following Thanksgiving. This year's convention will be held at the **La Salle Hotel in Chicago on November 25th and 26th.** The Association through this convention gives up-to-the-minute developments in science and mathematics teaching by recognized experts from all parts of the United States. It also gives the members an opportunity to become acquainted with their speakers and with each other. The Association believes this convention renders a valuable service to teachers.

The Association publishes a yearbook each year. It contains 70 to 80 pages and is mailed to members the first part of November. The yearbook gives a record of the activities of the Association. It includes the program for the annual convention, membership of committees, descriptions of new books, equip-

ment and apparatus through its advertisements, and a list of the members. Teachers consider the yearbook a valuable record of the new developments in science and mathematics teaching.

If you desire to have a copy of the 1938 yearbook promptly when printed, and with your name included, please send your membership fee to **W. F. Roecker, 3319 N. 14th St., Milwaukee, Wisconsin,** promptly.

The Association owns the journal, SCHOOL SCIENCE AND MATHEMATICS. Nine issues are published each year. A membership gives a year's subscription to the journal and part ownership in it. The journal is free from debt and has a reserve fund sufficiently large to meet all outstanding obligations at any one time.

In nine issues each subscriber gets: (1) About 1100 pages of printed matter, or the equivalent of three average sized books in content or method. (2) A review of 50 to 100 books. (3) A description of from 100 to 150 books and pieces of apparatus through its advertisements. (4) Fifteen to twenty articles or reports in each issue, or from 135 to 180 per year—about one cent per article. (5) Many mathematical problems, new demonstrations and new techniques in teaching.

If you have some new methods of teaching, a new demonstration, or a new use of some piece of apparatus, send a report to the editor. The Association is very anxious to give teachers an opportunity to have their opinions and methods published in the journal.

The Association has several committees actively engaged in solving some of the most serious problems in the teaching of science and mathematics. You have an opportunity to become a member of one of these committees. You will be assigned to a committee as soon as you make your choice known.

The activity of the individual members of any association is the most important factor in its success. Any association succeeds in the proportion in which its members make worth-while contributions. Each member, then, ought to ask himself these questions:

(1) Have I tried to inform teachers of science and mathematics of the activities and purposes of the Association? Have I done this well enough to influence them to become members of the Association? How many new memberships have I sent in to the Association? There is a membership blank in this issue of the journal.

(2) Do I attend the annual convention? If not, why don't I? Do I have any real excuse for not attending? Do I offer to take part in the Convention and help in some way to make it successful? The complete program for the 1938 convention will be published in the November issue of this journal. Do I give other teachers information about the annual convention and the excellent program it has to offer?

(3) Do I write articles for the journal? Do I encourage others to submit articles? Do I show my copies of SCHOOL SCIENCE AND MATHEMATICS to other teachers?

(4) Do I take an active part in some committee? Do I suggest new problems for the Association to undertake? Am I interested in having the Association set up a future policy of action? How can I help the Association in the formulation of such a policy?

(5) Am I doing my part to make the **Central Association** a successful and worth-while organization in improving science and mathematics teaching?

If I do, I will meet the other members of the Association at Chicago on November 25th and 26th and bring at least one new member with me.

Sincerely yours,
Ira C. Davis, *President*

AN UNUSUAL QUARTZ CRYSTAL

One of the largest and finest quartz crystals ever to enter the United States went into the vaults of the Bausch & Lomb Optical Co. in July. Coming from the Province of Minas Geraes in Brazil, where it was brought by mule pack from the diamond section of the Serra da Mantiqueira range, 1,500 miles from the coast, the huge crystal weighs sixty-three pounds and cost $18.00 per pound. Based on optical quality, experts believe that it surpasses any museum piece of this type in the country.

Although quartz, a form of silica occurring in hexagonal crystals, is distributed throughout the world, no deposits of suitable optical quality have been found in the United States. Brazil is the chief source of supply.

The crystal is solid matter in its most perfectly developed and naturally organized condition. Its exterior is characterized by a form of extraordinarily regular geometrical design. The internal structure is, likewise, so regular that the arrangement of the structural units, or chemical molecules, is precisely the same about one point as every other point.

BIOLOGY BRIEFS

Biology Briefs is a service publication issued monthly from September to May by Denoyer-Geppert Company, 5235–57 Ravenswood Avenue, Chicago. It presents useful, interesting and unusual articles written in a simple, non-technical style which are not ordinarily available to biology teachers in other literature. Sent free on application to biology teachers and school officials. To others the subscription rate is $1.00 per year.

WHAT ARE YOUR OPINIONS ABOUT TEACHING SCIENCE IN THE ELEMENTARY GRADES?

By David W. Russell
National College of Education, Evanston, Illinois

Every now and then it's a good idea to take a little "time out" from your everyday whirl of teaching and think about some of your educational views. Here's a chance to confirm your ideas on the teaching of science in the elementary grades by checking a questionnaire and comparing your answers with the responses of fifty-one well known educators which will be published next month in School Science and Mathematics.[1]

Your time will be well spent if you complete the check-list on these pages especially at this time of the year when schools have been opened for only a short time and all of us are planning to do bigger and better things with our first month of enthusiasm. Then, too, the demonstration centers, classes and panels of the summer schools have left us with new and old ideas that have been highly praised or blasted to the winds, and some of the educational studies from the annual spring and summer production are beginning to appear. As a result, many of us may be wondering more than ever about this thing called "progressive education" with its multitude of interpretations or we may be speculating on how long the good old topic "Democracy in Education" will continue to serve as a headline for educational meetings and study groups.

But casting aside our speculations and getting back to our schools which have just opened and the many children who are crowding into the classrooms, many elementary school teachers have been spurred on to improve their elementary science programs or they are teaching science for the first time. More power to all of them for science is comparatively a new field of activity in the elementary grades[2] and within the last few years it has quietly climbed until it now ranks with the "three R's" in many schools. Science is being taught by lectures, by activities of all

[1] All the data used in these two articles have been taken from *An Analysis of Practices and Opinions Concerning the Teaching of Science in the Elementary Grades*, by David W. Russell, Western Reserve University, 1938.

[2] Nature study was considered for the elementary schools over forty years ago. For good references see *Contributions of the Oswego Normal School to Educational Progress*, by Andrew P. Hollis, 1898; *Nature Study in the Common School*, by Wilbur S. Jackman, 1891; *The Nature Study Idea*, by Liberty Hyde Bailey, 1903 and the early yearbooks of the National Society for the Scientific Study of Education.

kinds,[3] by radio,[4] and many other methods and it certainly offers a wide-open opportunity for creative and stimulating classroom activity as well as green pasture for some good educational investigation. In view of all of this, the questions, should science be taught in the grades, how should it be taught, and what should be taught, and numerous others are answered by many controversial ideas. As far as including science in the elementary grades is concerned the "ayes" are far in the majority but there are still many "nays" who doubt the value of science compared with other fields of activity that contribute towards the growth of the child and his immediate needs.

A. Thirteen Questions to Answer

Many ideas on the subject of elementary science have been written in periodicals and a few in educational textbooks during the past twenty years. To organize these ideas on a more practical and workable basis the following inventory was made to give us an idea of where we stand or where we are going.[5] The check-list was divided into thirteen parts and arranged in question form because each of these questions was repeatedly asked in one way or another in the six hundred references that were surveyed. To supplement the thirteen questions, eighty-five subordinate items were added so that the questions could be answered while keeping in mind a consistent attitude whether it was conservative, intermediate, liberal, or some sort of an educational blend. In trying the questionnaire, each of the eighty-five items should be checked and, while no far-reaching conclusions can be reached, the experience of comprehending and checking the statements will provide some worth-while interests, pleasure, and stimulation especially if you are on your toes and know your educational vocabulary and some of the recent investigations and conflicting viewpoints about teaching elementary science.

B. How to Answer the Questions

This is the way to begin. Ask yourself the question, "Though I agree that science should be taught in the elementary school,

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[3] For an excellent book describing elementary school science activities see W. C. Croxton, *Science in the Elementary School*, McGraw-Hill Co., N.Y., 1937.

[4] Some of the most recent experimenting with teaching science by radio has been done by Mary Melrose of the Cleveland Public Schools and Harry Carpenter of the Rochester Public Schools.

[5] This questionnaire was also sent to seventy-five recommended schools as an aid to survey the practices in vogue in teaching science in the elementary grades.

just why should it be taught?" This question was recently put to a class of forty teachers preparing to teach science and it was surprising that few answers were given so let's see if we can do better! Listed under Part A are the eight reasons that have been most commonly given for teaching science in the grades. Read each statement and check your opinion of each reason by marking an "X" in the appropriate column. The columns are headed with letters which mean, SO—strongly opposed, O—opposed, I—indifferent or uncertain, F—favorable, and VF—very favorable. But here is a warning! It is very important to interpret the statements according to their general everyday meaning so don't throw yourself into a supercritical attitude, philosophize too much, or apply an etymological analysis to each word or phrase. Of course many of the words and phrases will suggest qualifying comments that might well apply to the statements if they are to cover particular situations, for after all, there is no pattern that fits all schools. The inventory is intended only to give some basic viewpoints and serve as an orientation of ideas related to the teaching of science in the elementary grades. Now go ahead, check all the statements, go over your responses several times and be ready next month to compare your ideas with those of the fifty-one well known specialists in curriculum construction and elementary science education for whether you are conservative or liberal there are some surprises in store!

PART A. WHY TEACH ELEMENTARY SCIENCE?

The teaching of science in the grades is justified because it . . .	SO	O	I	F	VF
1. helps children to appreciate their environment and to understand important relationships of living things.					
2. tends to raise the achievement in science in the upper grades due to preparation in the lower grades.					
3. offers good opportunities to develop favorable character and personality traits in children.					
4. aids children to form habits and attitudes of scientific thinking and scientific doing.					
5. provides information which children can use in their everyday living.					
6. uses subject matter that is naturally interesting and stimulating to children in elementary grades.					

	SO	O	I	F	VF
7. offers good approach to other elementary subjects and activities.	—	—	—	—	—
8. provides a good avenue of approach to incidental sex education at an early age.	—	—	—	—	—

PART B. SELECTING THE FIELDS OF SCIENCE

Subject matter in the elementary school science curriculum should . . .

1. combine the elements of nature study and natural science throughout the elementary grades.	—	—	—	—	—
2. combine important phases of natural science and physical science throughout the grades.	—	—	—	—	—
3. strongly emphasize nature study in the primary grades and lead to a growing emphasis upon physical science in the elementary grades.	—	—	—	—	—
4. depend upon no general plan for including certain fields of science but should include material that is best adapted to interests and attitudes.	—	—	—	—	—

PART C. HOW SHOULD SUBJECT MATTER BE SELECTED?

The selection of content for the science program should be based on . . .

1. an analyses of subject matter prescribed in several good courses of study.	—	—	—	—	—
2. "children's interests" which have been reasonably determined by good research studies or from other sources.	—	—	—	—	—
3. topics related to children's observations, discoveries, and questions as nearly as possible at the time when they occur.	—	—	—	—	—
4. science phenomena in the immediate environment of the school or the home.	—	—	—	—	—
5. children's ability to understand science phenomena according to studies that have been made.	—	—	—	—	—
6. the principle that science in the elementary grades should be taught as a foundation for the work that is to come in the upper grades.	—	—	—	—	—
7. children's current needs for understanding, enjoyment, and safety in living their own lives.	—	—	—	—	—
8. common experiences of children at home and at school including other subjects as well as science.	—	—	—	—	—
9. an analysis of well-known elementary science textbooks or readers.	—	—	—	—	—
10. seasonal or other natural changes in environment.	—	—	—	—	—
11. the needs of the community for an understanding of the principles of elementary science related to everyday activities.	—	—	—	—	—

PART D. WHO SHOULD TEACH ELEMENTARY SCIENCE?

SO O I F VF

The elementary school science classes should be taught by . . .

1. a specially trained elementary school science teacher who may have other incidental responsibilities in the school. — — — — —
2. a special teacher who conducts the science classes in addition to some other classroom teaching responsibilities. — — — — —
3. the regular classroom teacher who teaches science in her grade as well as several other subjects. — — — — —
4. a science supervisor or visiting teacher who gives demonstration lessons; the classroom teacher directs the work between visits. — — — — —
5. one of a group of regular classroom teachers who assumes the responsibility of the science program according to agreement with the other teachers. — — — — —

PART E. HOW SHOULD ELEMENTARY SCIENCE BE TAUGHT?

Learning experiences in elementary school science should be provided by . . .

1. the incidental method, or developing interests in science phenomena at the time when these interests seem evident. — — — — —
2. using a definitely planned unit to be completed within a specific number of class periods, days, or weeks, but including provisions for individual differences. — — — — —
3. a prepared activity unit with an elementary subject as a core but with adequate opportunity for related science activities that may develop through children's suggestions and attitudes. — — — — —
4. a unit built around a science concept as a core and incorporating other fields of interest as the unit develops. — — — — —

PART F. SHOULD ELEMENTARY SCIENCE BE RELATED TO OTHER "SUBJECTS"?

An acceptable program in elementary science should be especially associated with . . .

1. the program of silent reading instruction. — — — — —
2. the course of study in geography. — — — — —
3. the course of study in arithmetic. — — — — —
4. the course of study in the social sciences. — — — — —
5. the health program including physical education, nutrition, and personal hygiene. — — — — —

	SO	O	I	F	VF
6. as many subject fields as are necessary to carry on the purposeful science activities.	—	—	—	—	—
7. activities that are basically in the field of science; learning experiences in other subjects should take place in the time allotted to them.	—	—	—	—	—

PART G. HOW SHOULD TEXTBOOKS BE USED?

For an acceptable program of elementary science there should be . . .

1. a standard or adopted textbook with the subject matter and the activities taken from the book.	—	—	—	—	—
2. a standard or adopted textbook to be used with other reference material such as magazines, pictures, library books, etc.	—	—	—	—	—
3. considerable reference material including field trips, magazines, etc., but using a textbook as the core of the curriculum or unit.	—	—	—	—	—
4. teacher motivated discussions, explanations, demonstrations, and related activities with references made to books only when actually needed.	—	—	—	—	—
5. several standard or adopted textbooks, perhaps one related to physical science, one to biological science, or some similar plan	—	—	—	—	—

PART H. SHOULD MUCH TIME BE ALLOWED FOR ELEMENTARY SCIENCE?

For an acceptable science program in the elementary grades . . .

1. at least a daily half-hour period at a scheduled time should be used for teaching science.	—	—	—	—	—
2. at least one hour each day at an appropriate time should be used for teaching science.	—	—	—	—	—
3. sufficient time should be allowed each day to develop the science of related activities according to the judgment of the teacher.	—	—	—	—	—
4. time spent in the classroom is immaterial as long as the children's responses are spontaneous and stimulating to creative activity.	—	—	—	—	—
5. children should be asked to spend considerable time out of school to carry on science activities in order to make the program continuous.	—	—	—	—	—
6. the time allotted should be as much as the time allowed for any other subject in the elementary school curriculum.	—	—	—	—	—

PART J. WHAT SPACE AND EQUIPMENT SHOULD BE USED?

For an acceptable science program in the grades it is a good policy to have . . .

	SO	O	I	F	VF
1. a special classroom equipped for science activities.	—	—	—	—	—
2. a well-equipped science laboratory arranged for demonstrations, lectures and individual experiments.	—	—	—	—	—
3. inexpensive and free science material to use in the classroom and in the laboratory.	—	—	—	—	—
4. space in the regular classroom to use for science experiments and related activities.	—	—	—	—	—
5. the outdoors as much as possible as the science laboratory.	—	—	—	—	—
6. material such as exhibits, films, and pictures furnished by museums, visual education bureaus and other organizations.	—	—	—	—	—
7. no special equipment but to depend upon reading, discussion, and explanations for instruction.	—	—	—	—	—

PART K. IS THE RADIO IMPORTANT IN THE ELEMENTARY SCIENCE PROGRAM?

Radio broadcasts can be made an integral part of the science program in the elementary grades by . . .

1. including them as a part of the regular elementary science course for all grades.	—	—	—	—	—
2. having the use of the broadcasts optional with each classroom teacher of science.	—	—	—	—	—
3. making the radio broadcasts the core of the science program in all classes.	—	—	—	—	—
4. using radio broadcasts to supplement and intensify the regular science program in all classes.	—	—	—	—	—
5. providing supplementary material explaining the nature of the broadcasts several days before the radio programs.	—	—	—	—	—
6. utilizing radio broadcasts as enrichment material for those pupils who voluntarily listen at home or at school.	—	—	—	—	—
7. making radio programs a part of the required home assignment.	—	—	—	—	—

PART L. HOW SHOULD WE MEASURE CHILDREN'S ACHIEVEMENT IN ELEMENTARY SCIENCE?

Children's achievements in the elementary science program should be evaluated by . . .

1. objective measurement of their knowledge by using standardized tests.	—	—	—	—	—
2. objective measurement of their knowledge by using teacher-made tests based on the material that has to be taught.	—	—	—	—	—

	SO	O	I	F	VF
3. a rating plan, check-list, scale, or record blank for the teacher's evaluation of children's appreciation and interest in elementary science.	—	—	—	—	—
4. a rating plan, check-list, scale, or record blank for the teacher's evaluation of children's performance in science activities.	—	—	—	—	—
5. objective and subjective measurement of children's ability to use scientific facts and principles in their reasoning.	—	—	—	—	—
6. use no rating scale or measurement other than the teacher's judgment of the children's behavior and attitude in significant situations of living.	—	—	—	—	—
7. objective and subjective measurement of children's understanding and adjustment to their environment.	—	—	—	—	—

PART M. WHO SHOULD SUPERVISE THE ELEMENTARY SCIENCE PROGRAM?

The elementary science program in a city school system should be supervised by . . .

1. a special supervisor in science with advisory capacity for grades one to twelve.	—	—	—	—	—
2. a special supervisor in science with advisory capacity for grades one to six.	—	—	—	—	—
3. a specialist whose work is to demonstrate science-teaching in the grades.	—	—	—	—	—
4. the elementary school supervising principal.	—	—	—	—	—
5. the head of the elementary science department or general science department.	—	—	—	—	—
6. the classroom teacher using her own means of supervising.	—	—	—	—	—

PART N. WHAT NAME SHALL WE GIVE TO OUR ELEMENTARY SCIENCE CURRICULUM?

The most appropriate name for the science program in the elementary grades is . . .

1. Elementary Science.	—	—	—	—	—
2. Grade Science.	—	—	—	—	—
3. Science in the Elementary Grades.	—	—	—	—	—
4. Science in the Elementary School.	—	—	—	—	—
5. Natural Science (in the Grades).	—	—	—	—	—
6. Nature Study (in the Grades).	—	—	—	—	—
7. Nature Study and Elementary Science.	—	—	—	—	—
8. Elementary Science Course of Study.	—	—	—	—	—

SOLID GEOMETRY MADE MORE INTERESTING

By Marvin C. Volpel
Sturgis High School, Sturgis, Michigan

During the first semester of the past school year, the writer taught a class in solid geometry. Its membership consisted of ten boys from the senior class. Because of their high scholarship and great interest in the subject field, they responded generously and whole-heartedly to many suggestions from the teacher. Among these suggestions was the request that each boy should submit a semester project before he would be allowed to write his final examination. Many ideas were advanced during an informal discussion on this matter. The following types of topics were suggested for investigation: Solid Geometry on the Farm, Solid Geometry in the News, Solid Geometry in Architecture, Solid Geometry in the Home, Solid Geometry in the Shop, Solid Geometry and Navigation, Solid Geometry and Physics, and others.

The assignment was made for the following purposes: (1) to set the boys off on a piece of research work of their own choice, (2) to find out how solid geometry is related to life, (3) to afford a leisure time activity, and (4) to find out what opportunities are available for correlations with solid geometry. The instructor was very gratified with the results of this experiment and the purpose of this brief paper is to share with others some of his enthusiasm and joy over a few of the projects submitted.

The textbook which was used as a basic text contained a picture of the Taj Mahal with the notation that it was considered to be one of the most beautiful buildings in the world. This picture and a few comments which the teacher made aroused every member of the class. Two boys became so interested that they constructed a model of the famous mausoleum. The model was made of cardboard and matches. The cardboard frame was covered with the wooden parts of matches, which were broken into smaller pieces to give a marbled effect. The five domes were made of plaster of Paris and then gilded. The entire wooden structure was shellacked. The building is square with each of the four corners cut off and presents the same appearance when viewed from either side. The boys realize that the miniature monument is not complete but they are satisfied that in 180 hours of work and play they have achieved this result. The contents of ten boxes of matches were used in its

construction and the pint jar of match heads created almost as much interest as did the model when both were exhibited.

One boy made a study of the different kinds or types of columns. He used beautifully mounted pictures in booklet form to convey the results of his many hours of research and organization activities. Each picture is labeled to include the type or style of architecture with special emphasis on the classification of pillars, the name of the temple or building, and its location.

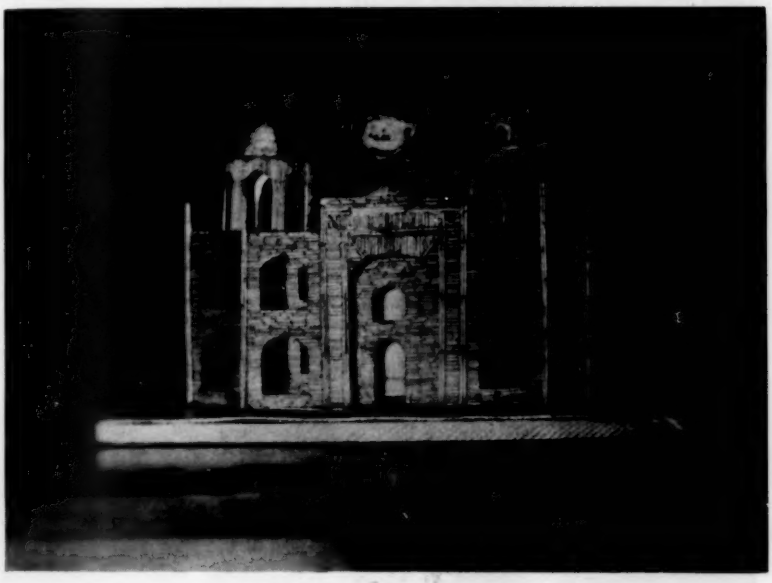

FIG. 1. A model of the Taj Mahal.

Another boy wrote a summary of the solid geometry used in the home, while one made a layout of several solids in assorted colors mounted on a black base. A twenty-pointed star, built upon an icosahedron as a base, was also submitted.

Some unusual solids were made "just for fun" during the year. Just before Christmas the boys made many-shaped solids and covered them with tinfoil, cellophane, red and green paper, and artificial snow; all of which were suitable for tree ornaments. Some of the boys made solids of celluloid. One solid consisted of a cylinder with a tetrahedron, a cube, and an octahedron suspended on a string inside. The boys had some unusual experiences gluing the sides together. In the early weeks of the course the boys made models of the more difficult propositions. One

of these models was built of wire and placed inside a worn-out radio tube.

At the close of the course an exhibit of these projects was made. Needless to say, these objects attracted much attention and created much interest among the members of the student body. Also the members of the class derived much pleasure and satisfaction from the display of their projects. Several pictures of the solids and projects were taken by one member of the class who has become very adept in photography. He also developed prints for other members of the class.

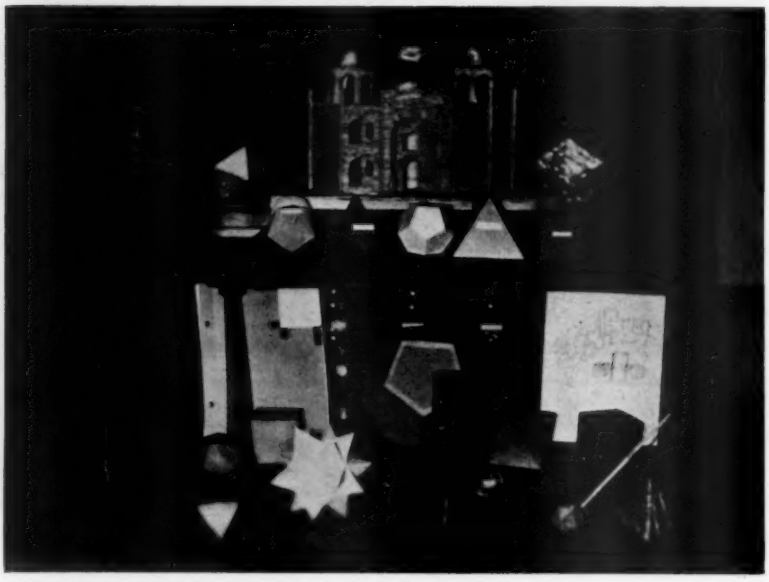

FIG. 2. An exhibit prepared by the class in solid geometry.

RED CROSS ON TREASURE ISLAND

The American Red Cross will put several types of disasters "under the microscope" at the Golden Gate International Exposition, in 1939. In the Hall of Science, on Treasure Island in San Francisco Bay, the Red Cross will dramatize its plans for the prevention, control and relief of these catastrophes, which are classed as "diseases of the social body."

War, famine, drought, floods, epidemics and conflagrations will be visualized in displays which show the type of relief work required in each case, and the cost of relief will be compared with costs of preventing the "preventable" disasters. Decision to participate in the World's Fair of the West followed a recent visit to Treasure Island by Norman H. Davis, former Red Cross chairman.

THE CORRELATION OF THE MARKS IN CERTAIN HIGH SCHOOL SUBJECTS WITH THOSE IN COLLEGE PHYSICS AND COLLEGE CHEMISTRY

By C. A. Foster
Nebraska State Teachers College, Kearney, Nebraska

Four years ago, survey courses in Physical Science were inaugurated in the State Teachers College at Kearney. These courses are required in certain curricula. Almost immediately it became apparent that there was considerable difference in the physical science background of the students entering these survey courses.

The possibility of obtaining more definite information on this problem, by the investigation of high school grades in the physical sciences and the correlation of these grades with the grades in the college survey courses, was considered. This led to the idea of making the same sort of study of the factors bringing about a variability in the physical science background of those entering college physics and general chemistry courses.

The purpose of this paper is to discuss briefly the results in so far as they apply to general physics and general chemistry.

In an article appearing in Volume 22, page 601, School Science and Mathematics, 1922, appears a study of the opinions of college teachers of physics on the question as to whether their students have been helped in their progress in college physics by a previous study of high school physics. Some say that it does help; others, that it makes no difference whether they have or have not had high school physics; still others, that they would rather have students with no previous training in high school physics.

In a more objective study summarized in *The Second Digest of the Teaching of Science*, #162, the author states as a result of his study that there are distinct outcomes of the study of high school physics in the form of ability to solve problems peculiar to the course, and that the effect, although significant, is not marked.

Another study appearing in the *Journal of Educational Research* for March, 1926, (Volume 13, page 199) shows a comparison of the grades in college general physics of those who have studied physics in high school, and those who have not. The results are as follows:

High School Physics		*No High School Physics*	
A	2.2%	A	2.5%
B	15.5%	B	5 %
C	24.5%	C	27 %
D	33 %	D	30 %
E	24 %	E	35 %

Comparison of grades in our own study at Kearney shows average grades of 82.58 for those with high school physics as compared with 79.85 for those without high school physics.

I have not been able to find any published study of this problem, based on partial correlations, which permits the elimination or partialing out of certain factors or the making of these factors constants. This is the fact which determined the procedure followed in this study.

Data were obtained as follows: Names of those taking college physics and college chemistry for the past five years were obtained from the class record books of the department. High school grades in physics, chemistry, and mathematics were obtained from the office of the registrar. Data on intelligence tests administered to students in classes in "Introduction to Education" were obtained from the Education department.

There follows the procedure and results as applied to physics. Zero order correlations were obtained between college physics and high school physics; college physics and high school mathematics; college physics and I. Q.'s; high school physics and I. Q.'s; high school physics and high school mathematics; high school mathematics and I. Q.'s. The necessary first order and second order correlations were determined in order to show the relationship between college physics marks with high school physics marks, high school mathematics marks, and with intelligence, in each of which correlations, other factors are assumed to have been eliminated or to be constant. The results follow.

Zero Order Correlations:		
General Physics—I. Q.	.77	± .33
General Physics—High School Physics	.74	± .034
General Physics—High School Algebra	.69	± .040
General Physics—High School Geometry	.66	± .043
High School Physics—I. Q.	.34	± .096
High School Physics—High School Mathematics	.66	± .034
High School Mathematics—I. Q	.49	± .048
Partial Correlations of First Order:		
General Physics—High School Physics eliminating Intelligence	.79	
General Physics—High School Mathematics eliminating Intelligence	.62	

High School Physics—High School Mathematics with Intelligence eliminated	.50
General Physics—Intelligence, with High School Physics eliminated	.81
General Physics—High School Mathematics, with High School Physics eliminated	.37
Intelligence and High School Mathematics, with High School Physics eliminated	.37

Second Order Correlations:

General Physics and High School Physics with all other factors eliminated	.70
General Physics and Intelligence with all other factors eliminated	.77
General Physics and High School Mathematics with all other factors eliminated	.13

In interpreting these results, it must be kept in mind that the partial correlations give the most accurate picture of the situation, when the factor or factors partialed out, contribute to both the others, and that, if one or both variables remaining are causes of the variable or variables partialed out, there is somewhat too much elimination in the process.

With these things in mind, if we look at the partial correlation between high school physics and college physics (.70) in which the factors of high school mathematics and intelligence are partialed out, we see that both the eliminated factors might reasonably be supposed to contribute to the two remaining and that the figure obtained should be fairly accurate. In the case of college physics and intelligence, however, (.77) at least one of the variables remaining might be suspected as contributing to one or more of those partialed out, so that the figure obtained may be slightly too low. Also in the case of college physics and high school mathematics the figure may be somewhat too low.

We might make, then, the following interpretations from our data:

1. The influence of high school physics on success in college physics seems to be high.
2. The influence of native intelligence seems to be still higher.
3. But the influence of high school mathematics seems to be negligible.

It would seem then that intelligence is the most important factor tending toward success in college physics. Incidentally, our study also shows that the average I. Q. of the physics group in college is 109, while the general college group with approximately the same classification is 105.

We must conclude also that success in high school physics is far from the negligible factor some college teachers would have us to think.

The conspicuously insignificant effect of high school mathematics may be understood when we remember that possibly important factors contributing to success in high school mathematics are also important factors in college physics, and that possibly the importance we have usually assigned to high school mathematics has in reality come to a great extent from the native intelligence of the student. We might also notice that most of the mathematical principles made use of in physics, except possibly those usually reviewed at the beginning of the course, are principles of arithmetic, or the simplest algebra and might be expected to have been mastered earlier than the high school course.

Similar statistical treatment of like data on general chemistry students, shows that neither high school physics nor high school mathematics seem to have any appreciable effect on college chemistry, the principal factors being high school chemistry (.63) and intelligence (.607).

There are, of course, faults which may be found with interpretations made from a study of this kind. The results will no doubt depend to a certain extent on the type of course given. Also, in this case, only one college is involved. The high schools included, however, probably represent a cross section of central Nebraska. There are also possibly other factors having an effect on college physics which were not included in the statistical treatment. Reading ability, which appears not to correlate so highly with intelligence at the college level as at the elementary level, may be a factor. The element of interest in science, not easily measured, may also be a factor.

In spite of the limitations of the study, however, we feel that it gives some interesting information on what have been moot questions.

We would be interested in a similar investigation involving a larger number of colleges, and more widely distributed geographically.

Be sure to read Mr. Neal's message on page 756.

A GEOGRAPHER LOOKS AT THE RECREATION-CONSERVATION PROGRAM*

By W. Elmer Ekblaw
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Though recreation and conservation may be coordinately linked in designating a conference like this assembled this week-end, they can not be considered of equal weight, for from any point of view one forms but part of the other. Conservation is an element that recreation, like all primary or major uses of the land, must consider, if we make conservation the objective of this Conference; if recreation be the goal about which the Conference is crystallized then naturally conservation forms but one feature, important but incidental, in the deliberations and discussions. It is essential to the purpose of this paper that I definitely clarify the relationship between the two functions which have been associated in the title, and state that conservation constitutes the theme of my paper and that anything I may say about recreation is dependent from it, attached to it.

That the point of view from which I approach my subject today has been specifically designated the geographer's, makes it incumbent upon me to define that viewpoint, particularly since so much confusion attends the meaning of modern geography. The geographer's point of view arises from place as the center or core about which his science, his discipline, is built up. As botany is centered upon plants and zoology upon animals; as geology is centered upon rocks and astronomy upon stars; or as history is centered upon time, so geography is centered upon place. Geography then concerns itself with the attributes of place, with relations between the activities or qualities of any one place, or with relations among attributes of one place and those of other places, whether they be physical, biological, or strictly human attributes.

The discipline of geography arises from the subjection of its facts to the criteria of place relationships. Though the place relationships of man are naturally most important as described and interpreted in the several aspects of human geography—anthropogeography, political, social, or economic geography, or historical geography, or others—the place relationships of all things other than man just as surely constitute geography. Thus we may have plant geography, soil geography, agricultural geog-

* Read before the State Recreation Conference, Amherst, Massachusetts, March 12, 1938.

raphy, the geography of disease, of grasshoppers, of ocean trade, of highways, or of telephone poles. The criterion by which a fact or truth is classified as geographic or non-geographic is whether or not it be related to place, whether or not it represents an attribute or relationship of place.

With understanding between us as to the point of view of the geographer, we may now take up primarily the relationships of conservation to place, that is the manner in which conservation affects or is affected by the attributes of any place or region, its relationship to site or location, relief, climate, soil, plant and animal cover, or any other of the manifold attributes of place; and secondarily the relationship of recreation to similar attributes of place.

Conservation as such is but one stage in the evolution of land utilization, that is use of the terrain, the climate, the life, and the resources of any place or region. The initial step in such land use is best designated by the term "exploitation," the stage wherein use of the land is guided solely by need or expediency without the opportunity or possibility of regard for other considerations beyond the moment. It is a stage wherein necessity dictates the policy, the program, of them who use the land. It must perforce be, and generally is, careless of consequences, indifferent to the future, reckless in method. Exploitation is the stage of the pioneers, of the forelopers, who must be careless and ruthless to survive.

The second state more or less abruptly rises out of the first when the circumstances of the pioneer change to those of the settled occupant, who realizes that depletion of soils, denudation of forests, dwindling of streams, destruction of wildlife, are consequent upon the exploitation that characterized the pioneer economy and society. The realization that his resources have been substantially diminished, his opportunities significantly curtailed, startles him, appals him, awakens him to resentment and alarm, and to frantic efforts to redeem the lost or the destroyed, to recover the vanishing, to restore the depleted.

Just as the first stage remained indifferent to consequences and failed to appraise the effects of its reckless exploitation, so the second stage, radical, resentful, swayed by rancor of the moment, embarks upon a reclamation policy which may be as thoughtless, as careless, as the first, formulated in sentiment rather then sense, in alarm rather than considered good judgment.

The third stage in land utilization, generally the final adjustment of man to the attributes of his place, his land, comes when the pendulum of his clock on settlement has swung to the two extremes and settled down to the steady slight sway that represents nice adjustments to soil, to weather, to the needs of the folk of the region. It is apparently to this third stage of wise conservative utilization that we are attaining, having, I hope, passed long ago the far swing toward unrestrained exploitation and more recently the opposite far swing toward extreme conservation. We are now settled, I trust, to the steady, well regulated policy of using our land as a carpenter uses his plane and saw, or as a gardener tills his soil, discreetly and conservatively, without jeopardizing the tools or depleting the fertility. Utilization will proceed on a sound basis, on planned and carefully considered principles so far as we know them.

And herein lies the opportunity for service that the geographer sees before him. I would not imply that the geographer's opportunity is one whit more significant than the geologist's, the chemist's, the biologist's, or the economist's, but I would hold that better than any one of them, if he be worthy of his science, the geographer can, and will, apply his discipline, the discipline of place, to the problems of land utilization insofar as place has any relation to them. To the accumulation and interpretation of place facts and relationships the geographer of today is especially trained, and this phase of the problem becomes peculiarly his responsibility. The coordination of purpose, plan, and effort would seem also to fall to him as his responsibility because of the complexity and interdependence of the place relationships which enter into his consideration of the problem.

To enumerate the wealth of resources and extent and character of advantages of our great land and to contrast them with such few lacks and disadvantages as accrue, would entail more time than I could reasonably expect this Conference to allocate my paper; and I fancy that to do so for this audience would be superfluous, a case of carrying coals to Newcastle. But suffice it to say that no other people on earth is so richly endowed with material resources and natural advantages as our nation is, from whatever standpoint we may compare our land with others.

And similarly the unity of our folk surpasses that of most other peoples, despite the wide range of our ethnic or national ancestry, of language or religion. From Maine to California,

from Florida to Washington, from Gulf to Great Lakes, from coast to inland plains, from forest to grassland, from mountain massif to river delta, we form one cultural unit, a people so alike in thought, speech, and deed, that it would be hard to find an alien, so far as culture is concerned, among us. We read the same books and magazines, study the same texts, see the same movies, laugh over the same "funnies" from one corner of our land to every other. We are thrilled by the same heroic exploits, shocked by the same callow crimes, angered by the same offenses, pleased by the same achievements, whether we be farmers, or fishermen, or mere college professors.

If a new style appear in the dress of some guest at the President's ball at the Metropolitan opera, or at the Kentucky Derby, every one fron Bangor to Kalamazoo and on to Pasadena has adopted it within a fortnight. Let Micky Mouse crack a new joke over the radio, or Mae West tell a naughty tale, and every one, whether of Irish or Greek, Swedish or French, Scotch or Yankee, ancestry is talking about it the next day in Boston or Tampa, Minneapolis or Southbridge, Detroit or Middletown. So much alike are we.

That unity of culture which is our great strength and which transcends any difference in other attributes like language, or religion, or race so-called, or ancestry, holds within it the possibilities of weaknesses as well. For if, through propaganda, or by errant leadership, we embark upon some new course of social, economic, or political action we are more likely to follow *en masse*, without the reluctance or hesitance that characterizes less unified citizenry or culture, less likely to ponder discreetly and carefully the course we take. As a geographer, I would respectfully submit that we have thus become unduly alarmed over the effects and consequences of the exploitation stage of the development of our land and the utilization of its resources, that we have been prone to accept without sufficient meditation unduly exaggerated tales of depletion, and denudation, and destruction consequent upon reckless pioneer economy, tales that protagonists of that policy or this, this program or that, tell in support of their panaceas for our present economic dilemma.

I would not detract from the seriousness of our losses, or the immediacy of our problems, nor would I question the sincerity of the motives that prompt the propaganda or shape the arguments by which we are persuaded, or almost persuaded, to engage in that experiment or the other; but I would earnestly

emphasize the wisdom of studying further, of much more carefully and exhaustively surveying, the premises upon which we conclude our plans and policies for the future. I would emphasize the need for calmer, more deliberate, integration of our programs, to the end that we shall not waste our substance further, that we shall not wear out our enthusiasm or break down the strength of our purpose, prematurely. We can not achieve conservation by a policy of non-use any more than we can achieve happiness by non-participation in the daily routine of the world's tasks.

We have only begun to understand our weather, our climate. Only within the last quarter century has soils science taken form. Only a small part of our vast domain has been thoroughly mapped. The significance of our flora and our fauna is only beginning to be appreciated. The value of our water resources, the extent and quality of our mineral deposits, still need to be more carefully evaluated. There is much, all too much, to learn before we may safely embark upon any radical departure from established, well-known paths toward progress in land utilization, and thus to wise conservation.

And what of recreation? Recreation as a business, too, is on the whole a recent development. Until we have made much more exhaustive surveys of recreational attributes, and inventoried more carefully the recreational advantages and disadvantages of every region, shall we be in position to lay down adequate, integrated plans for specialization in recreational use of the land, or to set aside certain areas for recreational purposes solely. Recreation is one of the amenities among the activities of life, incidental rather than primary. Important as it is, important as a means to health and happiness, but not so vital to life itself as seeking food, or building ways or shelters, or forming associations in industry or society, or passing on from one generation to the next the aggregate of social experience, which we call education, it does not entail immediate or major consideration except as it constitutes one essential element in the final integration of our plans for land use.

That its importance has won for it the position it holds in this Conference, indicates that it can not be, should not be, ignored. Since we now recognize its importance let us give the same thoughtful consideration to the bases upon which a sound policy of recreation use of the land shall be established, as the primary uses of the land have received, and are receiving throughout the land.

The place relationships of some phases of recreation are so patent that further course of development is obvious; but many such relationships are veiled in doubt or obscured in lack of authentic data, insufficiency of authoritative study and surveys. As in general problems of conservation as a part of land use, the geographer would emphasize the need for more exhaustive research into the fundamental problems of recreation programs, the accumulation of a larger and more detailed body of fact upon which to base further progress, and the similar need for a much more widespread coordination of plan, and effort, and program. The geographer considers that he has a service to give, a duty to fulfill, in helping assemble the essential required facts upon which to formulate a reasonable and sound program, to put it into successful operation, and to modify it from time to time as new inventions, changing conditions, or refined ideals demand.

BUREAU OF EDUCATIONAL RESEARCH IN SCIENCE

The following mimeographed materials have been prepared by the Bureau of Educational Research in Science. They may be secured in single copies or in quantity by ordering from Professor S. R. Powers, Director; Box 99, Teachers College, Columbia University, New York.

1. Report of a Committee Appointed to Consider a Proposal for an Enlarged Program of Work in the Field of General Education at Teachers College—53 pp. This is a general statement indicating the framework in which our project is set. (50¢)
2. Plan for Study of Process of Learning, by Anita D. Laton—9 pp. A general statement indicating the thinking that serves as a foundation for the source units. (15¢)
3. In Living Things there is a Selective and Balanced Exchange of Materials (and Energy) with the External World—14 pp. A source unit. It is the first one prepared and is not as complete as some of the others but is still very useful. (20¢)
4. Genetics, by Gertrude Wylie with assistance of Anita D. Laton, Joseph Schwab, John G. Pilley, etc.—38 pp. A fairly full statement, approximately the same as the one that is given in "Science and General Education." (45¢)
5. Life Span, by Anita D. Laton—42 pp. Another source unit, developed quite comprehensively. (35¢)
6. Scientific Method, by Anita D. Laton and John Pilley—67 pp. A source unit. (50¢)
7. Interrelations of Living Things, by Paul B. Sears—57 pp. Contains the material that would be used in a source unit. (40¢)
8. Use and Control of Organisms, by F. L. Fitzpatrick—72 pp. Contains the information that would be used in a source unit. (50¢)
9. Man's Use of Energy and Material from the Earth's Crust, by C. C. Furnas—31 pp. Information for a source unit. (30¢)
10. Human Growth and Development, by Paul B. Sears and Frank Jean —56 pp. Information for a source unit. (45¢)

A NIGHT IN 1838

By Ruth McDonell
Marygrove College, Detroit, Michigan

Cast of Characters

The Announcer
Dr. Matthias Schleiden
Dr. Theodor Schwann

Time: 1838, the late afternoon.

Place: Laboratory in the Anatomical Institute of the University of Berlin, Germany.

Setting: The following is a six minute script suitable for use as a radio broadcast in a high school biology laboratory, or as a dramatization in the classroom.

As a radio broadcast, arrange a table and stand near the microphone. On the stand have cases of slides and specimens from zoology; on the table place the microscope, with a slide in focus.

In the opening scene, the Announcer at the microphone, describes the laboratory according to the script. As he concludes the description, Schleiden and Schwann enter.

As a dramatization, this same scene may be enacted in the school laboratory, or may be set up temporarily in the front of the classroom. In that case, the Announcer becomes a narrator at the side of the stage, Schleiden and Schwann working at the table in the center.

Announcer. A Night in 1838.

Music: ten seconds—
fades gradually.

Announcer. Half a century before the powerful hands of Bismarck molded the German states into one huge empire Germany saw the termination of long scientific research. It was the search for the common element in the structure of all organisms —that tiny bit of protoplasm containing a nucleus that we call a cell. Many eminent names were associated with this work, Bichot, Mirbel, Brown, Wolff and a score of others, but standing above the rest as the scientists who established the cell theory are the names of the botanist, Matthias Schleiden and the zoologist Theodor Schwann.

Schleiden and Schwann worked alone, but they dined together one night and returned to the laboratory of the Anatomical Institute of Berlin to discuss and compare their work. It is at this meeting we see them now—two men who are exact opposites; Schwann, tremendously brilliant, untiring and ever cheerful; Schleiden, less clever, more easily discouraged and apt to be despondent. But at this moment individual differences

are forgotten, for a common interest engrosses their attention. The laboratory where the men work would seem inadequate in comparison with our modern laboratories. Yet the apparatus is adequate; the microscopes are crude but efficient. Now the men enter, and we hear them talking together—Mr. Schwann speaks.

SCHWANN. Give me your coat and be seated, Dr. Schleiden. How glad I am of this chance to discuss our work—it so seldom we meet! Ach, how dark it is getting—it seems every day that I have hardly begun my work before night falls and I must be finished.

SCHLEIDEN. Yes, so it seems to me at times, but then, darkness brings rest to tired eyes.

SCHWANN. Rest! who can rest with such restless thoughts and problems in one's mind? I would rather work whole nights than rest one minute, but do not let us waste our time idling in conversation. Come, tell me what have you been doing since our last meeting?

SCHLEIDEN. I have been working with plant tissue, Dr. Schwann, studying the embryonic cell structure. You know, Mirbel holds that the cell is an ovid structure surrounded by a membrane capable of changes in form, and I am convinced that he is right.

SCHWANN. I, too, have been working with the cells of embryonic tissue, but my work is with animal tissue; however the animal cell corresponds closely with your description of a plant cell. I have studied the cells in the dorsal chord of the embryonic frog and have determined that each cell is an individual, an independent structure, but that all these individuals work together in a complete harmonious whole. Like the individual threads in a cloth—each is distinct and entire in itself, but together all the threads are woven into one purposeful piece. Do you follow me, Dr. Schleiden?

SCHLEIDEN. Very clearly, but what of the content of the cell? Can you agree with the Englishman, Brown on his nuclear theory? I have found in each cell body of every tissue I have studied this circular nucleus—yellowish in color and granular in content—although at times the grains are not clearly distinct. Upon Brown's work I have based the whole of my experiments.

SCHWANN. Does Brown find the consistency of this nucleus variable?

SCHLEIDEN. Decidedly so! It is sometimes soft enough to dis-

solve in water and sometimes firm enough to bear considerable pressure. So great is my belief in this nuclear theory that I have come to the conclusion that the nucleus is the elementary organ in all vegetable tissue.

SCHWANN (Rising; speaking excitedly). The elementary organ in all vegetable tissue—eh? Look here Dr. Schleiden! Look into this microscope! Tell me, what do you see? (After a moment) Well?

SCHLEIDEN. This tissue contains cells similar to those we were discussing—m-m-m similar—I might add identical; the nucleus, the membrane, the shape. Yes identical, all of it. But, Dr. Schwann—this is not vegetable tissue.

SCHWANN (Excitedly). Vegetable tissue! No! That is a section of the dorsal chord of the embryonic frog—Look closely, man, are you sure of their identity? (Aside) Ah! if only—

SCHLEIDEN. Yes, the closer I examine this tissue the more apparent their identity becomes—but, Dr. Schwann, why the intense interest?

SCHWANN. Because *this identity* brings plant and animal tissue to a common point. If we can accept the cell as the general unit of life and as a common basis for the vital phenomena in both animal and vegetable kingdom, we have the basis for tremendous experiment. What a different outlook such an identity gives living things. It means a new science—biology! What possibility extends before us! Dr. Schleiden, future generations will record this moment!

ANNOUNCER. Little did Dr. Schwann know what degree of importance the annals of science would give to his discovery. But today a hundred years later we can see clearly what a huge field of experiment the enunciation of this fundamental principle has opened up. It has provided physiologists and pathologists with a means of knowing the structure of organisms in health and in disease. Its influence has been immeasurable in the progress of practical medicine; in fact it has become the very foundation on which both plant and animal biology have developed. In truth, Dr. Schwann, future generations *have* recorded that moment!

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SOME VALUES DERIVED FROM THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

A wide acquaintance in one's teaching field constitutes one form of progress. One cannot be widely acquainted in his field without taking part in an exchange of ideas which is sure to be broadening. Undoubtedly any average teacher of science and mathematics is certain to double his acquaintance in the field by attending conventions of the Association and meeting the people whose names he sees in the JOURNAL. The present writer is certain that his own acquaintances have been multiplied many times, and very profitably so, by having attended the last ten conventions of the Central Association. Meeting new people and discussing educational problems with old acquaintances is perhaps the greatest value which comes from attending these conventions. A very close second, however, would be the valuable discussions and demonstrations which come out of the general, sectional, and dinner meetings. SCHOOL SCIENCE AND MATHEMATICS is read by supervisors and novice teachers alike as a source of inspiration and information. For the average teacher the JOURNAL is a bonanza of ideas for better classroom work. It is a question whether any teacher of science or mathematics who wishes to keep up with the times and advance himself in his chosen profession can afford *not to belong* to the Association and attend its meetings.

N. A. NEAL

Have you read how the Central Association of Science and Mathematics Teachers can help you? See pages 729–731.

CURRENT ANSWERS TO THE QUESTION, "WHAT SHOULD THE TEACHER OF SCIENCE KNOW?"*

By Carleton E. Power
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In searching for a topic and speaker for this round table Doctor Moose happened to remember that I have been concerned for some time with the activities of a group of college and normal school teachers who have been concerning themselves with improving their product-teachers of science in the schools. So he approached me with the suggestion that I attempt to indicate in a limited time, being careful to emphasize the "limited," some of the current answers which we have reached with the idea that out of my report there might arise material for discussion. With your permission I shall read rather than talk in order to avoid time-consuming digressions which I might make if I merely talked along. This goes against my professional grain as I should prefer to develop some of my points with your assistance, thus, perhaps, exposing you without emphasis to one type of approach to knowledge which will be recommended during my reading.

As I thought over answers to the question of the morning it became evident that it would be better psychologically not to answer the question baldly but rather survey briefly some associated tendencies. A science teacher is a modern teacher and how does the modern teacher function? The emphasis is increasingly to see him as an educator in the broadest sense, in the interpretation of the *Thirty-First Year-Book* of the National Society for the Study of Education, as one who *leads* to life enrichment through participation in a democratic social order. This interpretation was foreshadowed in *Bulletin 35* of the United States Bureau of Education. Our studies in the history of education show how universal education has modified the old concept of education for the privileged few largely through college preparation. Most students never finish high school and what has the traditional college-preparatory program to offer them? "Gentlemen of the old school" cling to the idea of formal discipline from rigid courses in mathematics and science as giving permanent mental traits and habits of value but modern

* A paper read at a round table conference at New York State College for Teachers at Albany, March 20, 1937.

psychology has discounted that idea nearly 100% except for items involving common elements. How much have many of our college preparatory courses to offer in common elements toward life enrichment, etc.? We even find the efficacy of drill as a factor in learning questioned. Certainly drill has been greatly reduced in many school systems, a condition leading to the inference that "education" has been thereby softened.

Some of the factors in the life enrichment feature of education were elaborated in *Bulletin 35* mentioned earlier. Before, and perhaps lending to the report, and notably since, many school systems have attempted to make schooling more truly educational. Perhaps the most definite contribution has been made by the junior high school with its general or survey courses sometimes definitely organized with the participation factor, as opposed to the standard memoriter approach, emphasized. Thus, in some schools, the student learns to appreciate mathematics, not as a discipline, but as a tool for thinking; he does not study the history or civics textbook but present social and political systems, attempting to trace their development, analyzing and explaining them if possible, even attempting to predict consequences of present-day trends. Perhaps he does not get the rigid training the upper grades of the elementary school used to give but he learns to question authorities and movements and may even learn to think. If he reaches the high school he is sometimes branded as poorly grounded in fundamentals by his teachers there. I wonder, does his poor grounding or his questioning state of mind bother his teachers more? It should in fairness be stated that in many high schools the junior high school method of approach to understanding is operative.

In the field of science teaching what are the trends? I can take time to mention specifically but a few recent studies. *Bulletin 35* was soon followed by *Bulletin 36, The Reorganization of Science in the Secondary Schools* (1920). This was drafted by a committee of leading high school and college teachers of science who subscribed to the general principles of the aims of education stated in the earlier bulletin. The method of approach recommended for the new subject general science involves a *direct* solution of meaningful (to the student) problems by inductive development in many cases. The solutions reached will be meaningful generalizations usable in interpreting new items of experience in school and outside. It is noteworthy that this

report was published at a time when general science was developing as a junior high school science. Probably the form of some of the texts published since 1920 has resulted from the recommendations of the committee. In the field of general biology, the newest high school science, similar influence is shown. No noteworthy change in the books of chemistry and physics can be found.

Perhaps the next significant feature of note was the report of the Science Committee of the National Society for the Study of Education. This study appears to have been undertaken because of the changing educational philosophy, conditioned, perhaps by the marked decline in interest in science by students in the schools. The report of the committee, published in 1932, makes specific recommendations to which I shall return shortly.

Practically simultaneously with the above there was published the *Wisconsin Philosophy of Science Teaching* by a committee crystallizing the educational thought of over three hundred Wisconsin science teachers from which the following ideas are quoted.[1] "The purpose of science, as of any subject, is to develop ability in the individual to solve the problems which confront him. To solve these problems he will need (a) an attitude which will lead him to recognize and attack problems; (b) a scientific method of procedure which will be more efficient than a hit and miss trial and error method; and (c) a fund of information which will make it unnecessary for him to repeat the experimentation which has produced our present civilization." The following are suggested as some of the specific aims or objectives of science teaching: command of factual information; familiarity with laws, principles and theories; power to distinguish between fact and theory; concepts of cause and effect relationships; ability to form workable hypotheses; willingness to change opinion on basis of new evidence; freedom from superstitions; possession of interest in science. Obviously if these aims are to be reached the teacher must have more than factual knowledge himself.

A report of an investigation by The National Society for Research in Science Teaching published in 1933 shows a consensus of opinion essentially in agreement with the Wisconsin philosophy. Noteworthy items from this study follow. In order, the first three criteria involved in the organization of science courses are: (I do not like the wording) to explain some scientific

[1] *Wisconsin Journal of Education*, Nov. 1932.

attitudes and show how they affect man's thinking; to explain the methods of science and show how they operate in everyday affairs so as to be of most direct use to pupils in their everyday living. In order the plans of organization should be: use of personal, individual problems related to science; use of major topics having large social implications and involving the solution of important social problems; use of comprehensive generalizations of science in the forms stated by men of science. Again in order are the first three features of organization: in-class program consisting of the usual activities; judgment of out-of-class activities by estimates of specific traits of character evidenced by the out-of-class work; judgment of in-class achievement from scores on valid, reliable and comprehensive tests.

The *Thirty-First Year Book*, to which I return, emphasizes the desirability of restricting the materials "taught" to those which will be helpful in solving problems that come within the experiences of the pupils in class and out. The book contains lists of some important generalizations to be taught in the various science fields from elementary through high school selected on the following criteria: (a) do the experiences by means of which the generalizations are reached challenge the interests of the children? (b) are the statements of the generalizations suggestive to the teacher of the activities appropriate to the attainment of the objective sought? (c) does the generalization reached broaden the knowledge and help develop scientific attitudes and habits to aid in the solution of later problems which may be met? Note the weight given in each of these three studies: knowledge, methods of thinking, attitudes.

The materials presented to this point have to do with the content and spirit of courses in schools below the college level with definite implications for teachers of these courses. In the time which is left let us consider the modified question, "What shall the science teacher know and how shall he know it?" which has been partially answered already.

As an aftermath of the *Thirty-First Year Book* report a group of science teachers from teacher-training institutions of the northeastern states has been meeting semi-annually for the past five years in an attempt to reach a satisfactory answer to this question among others. It is because I have been a member of this group for some time that you are suffering this infliction. Inasmuch as several members of the Conferences were directly or indirectly concerned with the *Year-Book* the reasons for the

meetings are obvious. As a result of considerable simmering a product of definite import resulted at the Montclair Conference in November 1936. Again and again at that Conference came insistently the suggestion that a science teacher must know his science functionally. Essentially the practical application of the Wisconsin philosophy was recommended, although it was not mentioned at the meetings. The report applying most definitely to our problem was that of a committee charged with the suggestion of a program for the training of high school teachers of science from which I shall quote briefly. Note again the fact, method, attitude emphasis.

Among the courses for his degree the teacher should include a major of at least twenty-four hours credit, a minor of at least twelve hours, English and social studies for breadth as well as courses in the field of education (another major) for orientation and techniques. Among these education courses should be included one in observation and practice teaching in the secondary schools, the other in materials, methods and techniques of teaching science. Both of these should be given, preferably, by the science department of the teacher-training institution. Finally, to me one of the most significant recommendations, is the suggestion that the training in the science major and minor is to be such as to give a *functional* understanding of the major concepts in the fields of the biological and physical sciences, an adequate training in the use of the scientific methods of problem solving and the scientific attitudes toward problems arising in everyday life. The training must develop also in the candidate such skills in laboratory techniques as will insure his ability to perform experiments with success and with safety to his pupils. These last suggestions contain, to my mind, the answer to the title of the task of the committee and a summary of the present trends in the training of science teachers. The definite implication is that the high school teacher of science needs to know science as factual knowledge related to his environment *and* methods of obtaining that knowledge with the latter involved in attaining the first. Any description of the scientific method indicates this connection. One grave mistake of much of our teaching of science in college would appear to be based upon the unscientific belief that scientific habits of thought and approach to problems and scientific attitudes can be obtained and developed by assimilation of factual material presented, frequently without proof, by textbook and/or teacher. Could

anything be less scientific in fact? We know that the way to develop a habit or attitude, which is a habit, is to practice it in its environmental connection. The conclusion that the cultural values of science include its methods implies that one who would teach science in the schools must know *how* its useful generalizations were obtained through obtaining enough of them scientifically himself so that he shall have developed scientific habits of problem solving. This will require frequent appeals to the laboratory for data, not demonstration, with subsequent interpretation involving, for the student, an inductive approach to scientific interpretations and generalizations. Note that the laboratory, thus used, is not to check generalizations already accepted as valid but to serve in the development of an idea or concept which may have been unknown at the beginning of the study. This method of learning will give authority of book or teacher some measure of proof as contrasted with the common acceptance of word of teacher or book as authority. When one has discovered a relationship for himself he will be sure of its validity within the breadth of his data, will know how and why he knows, will develop self-confidence and will get training in definite methods of solving problems. If these problems are related to his environment he will find himself facing similar problems as they may arise in his classroom, when he is teaching in a way to have his class asking questions effectively and scientifically. No textbook approach can give him that.

If time permitted I should like to indicate how certain types of objective problems can be used to develop other scientific attitudes in students such as those mentioned in the Wisconsin philosophy. With these the high school teacher will be prepared to adapt his educative function to the community in which he lives, better appreciate the difficulties which his students face and thus direct their thinking and make positive contribution in the development of intelligently thinking men and women. Otherwise, why teach?

ENGINEERING PRECISION

U. S. Army Engineers estimated that it would take them 18½ months to dredge Treasure Island, site of the 1939 Golden Gate International Exposition, out of San Francisco Bay, and that it would cost $3,803,900 in WPA funds. They used eleven dredges; they pulled the last one off the job exactly 18 months and 15 days after the first one went on, and the job cost $4,100 less than the estimate.

ACHIEVEMENT OF STUDENTS IN COLLEGE ALGEBRA COMPARED WITH THE NUMBER OF SEMESTERS OF PREPARATION IN HIGH SCHOOL

By M. C. Bergen
Morgan Park Junior College, Chicago, Illinois

What effect does longer training in high-school mathematics have upon the pupil's achievement in college mathematics? That is to say, do students who have had six, seven, or eight semesters of high-school mathematics make better records in college mathematics than those who have had only four or five? College teachers of mathematics have often pondered over these questions but any formulated opinions are mere guesses due to the lack of factual evidence.

For the purpose of discovering the relative achievement of students the final grades for 291, in college algebra at the Morgan Park Junior College, under three different instructors, were classified as to the number of semesters of mathematics taken in high school. The Morgan Park Junior College does not group students according to preparation. Everyone takes the same three-hour course whether he has had four high-school semesters of mathematics or eight. This situation lends itself well to the conditions of the study.

The grades earned by the students, compared with the number of semesters of mathematics taken in high school are shown in Table I, and the same data in terms of per cent are shown in Table II. There is a direct relationship between the number of "A" grades and the number of semesters taken in high school. The increase is from 2.86% for students who have had four semesters, to 25.00% for those who have had eight. The increase in "B" grades is not so regular. From 15.71% for four-semester students there is a decrease to 12.00% for five-semester students, then an increase to 17.50% for six-semester students. The number of "B" grades for six-semester students is not much larger than for four-semester students but is decidedly larger than for seven-semester students where the lowest number is present. This is accounted for by the large number of seven-semester students who made grades of "A." For "B" grades eight-semester students again were highest, 41.66% achieving this grade.

TABLE I

GRADES EARNED BY 291 STUDENTS

Grade	Number of Semesters of High-School Mathematics					Total
	Four	Five	Six	Seven	Eight	
A	2	1	6	15	6	30
B	11	6	14	7	10	48
C	21	15	27	33	7	103
D	17	14	21	10	1	63
E	18	10	7	2	..	37
Drop	1	4	5	..	..	10
Total	70	50	80	67	24	291

TABLE II

GRADES OF 291 STUDENTS IN PER CENTS

Grade	Number of Semesters of High-School Mathematics					Total
	Four	Five	Six	Seven	Eight	
A	2.86	2.00	7.50	22.38	25.00	10.31
B	15.71	12.00	17.50	10.45	41.66	16.49
C	30.00	30.00	33.75	49.26	29.17	35.39
D	24.29	28.00	26.25	14.92	4.17	21.65
E	25.72	20.00	8.75	2.99	..	12.72
Drop	1.42	8.00	6.25	..	..	3.44
Total	100.00	100.00	100.00	100.00	100.00	100.00

It is interesting to compare the sums of "A" and "B" grades. The sum for five-semester students (14.00%) is lowest. Next in order are the four-semester students (18.57%), the six-semester students (25.00%), the seven-semester students (32.83%), and the eight-semester students (66.66%). Fully two-thirds of the students who had eight semesters of mathematics in high school made grades of "B" or better in college algebra.

On the other hand, the largest per cent of students who made a "D" grade are those who had five semesters of mathematics in high school (28.00%). Next in order are the six-semester students (26.25%), the four-semester students (24.29%), the seven-semester students (14.92%), and the eight-semester students (4.17%). The number of failures is definitely related to

preparation in high school. The largest number, 25.72%, occurred in the group with the least preparation. Next in order are the five-semester students (20.00%), the six-semester students (8.75%), and the seven-semester students (2.99%). There were no failures among the students who had eight semesters of preparation.

The sums for "D" and "E" grades are 50.01% for four-semester students, 48.00% for five-semester students, 35.00% for six-semester students, 17.91% for seven-semester students, and 4.17% for eight-semester students.

Of the students with six semesters of preparation, 6.25% dropped the course. This makes a total of 15.00% who did not satisfactorily complete it. Eight per cent of the five-semester students dropped the course bringing the total of those who did not pass to 28.00%. Of the students who had seven or eight semesters of mathematics in high school none dropped the course.

Considering an "A" as four points, a "B" as three points, and so on down to zero for an "E," the average grade for each group was obtained. The highest average thus found is for eight-semester students, 2.87 grade points. The seven-semester students are next with 2.34 grade points, then the six-semester students with 1.88 grade points, and lastly the two groups of least preparation each with 1.44 grade points. The average for all groups was 1.89 points.

Differences between the groups of students who had four and five semesters of mathematics in high school are negligible. But there are large differences when the groups who had six or more semesters are compared with those who had only four or five. Of course there are many factors involved here, such as the fact that many students who elect advanced courses in mathematics in high school do so because they find the work easy, or because they like it and would probably do well in college algebra anyway. But there can be no doubt that the experience and practice the students receive in advanced courses is of great help to them in their opportunities for success in college algebra.

Some of the most obscure and unrealistic thinking now being done in America is the product of minds that never knew which way a screwdriver turns to tighten a loose screw.—DAVID CUSHMAN COYLE.

TRENDS IN THE ORGANIZATION OF HIGH SCHOOL CHEMISTRY SINCE 1920*

By Carrol C. Hall
Springfield High School, Springfield, Illinois

For the purpose of definition the term "organization" as used here refers to the arrangement of the subject matter of high school chemistry into the form in which it is to be presented to the pupil or used by the teacher. Other phases of organization will be touched on as incidental parts of the discussion. The term "trend" is defined as a pronounced tendency or inclination extending over some period of time so as not to indicate some individual innovation.

The date 1920 was chosen because in that year the *Bulletin on the Reorganization of Science in Secondary Schools* was published. This document was a turning point in the organization of high school chemistry and offered a good point at which to begin the present study.

Chemistry is a traditional subject and is by nature a conservative one in its organization. To make its organization more difficult (it is difficult—complex—covers a wide range of material), there is a constant source of new material to be added—and it came into the secondary curriculum from the college course.

Chemistry has not been left out of the recent movements in secondary curriculum reorganization. Various attempts have been and are being made to "socialize," "humanize," and "modernize" high school chemistry. The application of the newer psychological knowledge has also been felt in the organization of the subject.

In speaking before a group of individuals who are actively engaged in teaching the subject I am sure that I will touch upon material that you are more or less familiar with or aware of. However, it is my wish to point out the trends as revealed by objective data and, if possible, point out some of the implications of these trends.

In an effort to discover the trends in the organization of high

* Presented to the Chemistry Section of the Central Association of Science and Mathematics Teachers, November 26, 1937, Cincinnati, Ohio.

The basic material of this paper was obtained from a Master's degree thesis presented in partial fulfillment of the requirements of that degree in the Department of Education at the University of Chicago. It was written under the supervision of Dr. W. L. Beauchamp, professor of Science Education.

school chemistry since 1920 from objective data the study was built up in four steps, as follows:

1. An analysis and investigation of various committee reports of national educational societies made since 1920 that related to the organization of high school chemistry.

2. An analysis and investigation of articles appearing in three science education periodicals: *Science Education*, SCHOOL SCIENCE AND MATHEMATICS, and the *Journal of Chemical Education*. The articles chosen were related to the organization of high school chemistry and were published in the issues dated from 1920.

3. An analysis and investigation of various courses-of-study published since 1920.

4. An analysis and investigation of a selected list of high school chemistry textbooks published since 1920.

In the original study a careful analysis and summary of each of the steps in the investigation was reported. However, since space will not permit such a detailed discussion I will confine myself to a few general remarks about each step.

The first step, the study of committee reports, revealed that fifteen reports dealing with the organization of high school chemistry have been published by eight different educational societies or organizations. These, of course, are organizations of more than local influence. The organizations that have contributed to the organization of high school chemistry since 1920 are: The National Education Association, the American Chemical Society, the National Society for the Study of Education, The University of the State of New York, The College Entrance Examination Board, The North Central Association, the Central Association of Science and Mathematics Teachers, and the Society for Curriculum Study.

The committee reports grouped themselves into three periods: 1920–23; 1923–27; and reports issued since 1927. In the first period there was a trend from the idea of formal discipline and acquisition of factual knowledge for college preparation to the emphasis of organization around the development of the individual and practical applications of chemical knowledge. During the years 1923–27 the committee reports were concerned with the trend of correlating college and high school chemistry. This culminated in the establishing of lists of minimum essentials for high school chemistry. Since 1927 the trend of organization as suggested by the committee reports has

shifted from life-application to life-preparation. This social emphasis has replaced that of individual development. There has been inaugurated a trend toward the development of certain habits, skills, and attitudes. An attempt has been made to organize the materials of chemistry on a more psychological basis—as suggested by the unit-method or the use of science generalizations.

From a study of three hundred sixty-two articles dealing with the organization of high school chemistry published in the three periodicals mentioned since 1920 it was discovered that two items could best be shown. They were: (1) the factors that have influenced the organization of high school chemistry since 1920, and (2) what bases for organization of new courses in high school chemistry have been proposed since 1920?

The factors which have influenced the organization of high school chemistry since 1920 when studied more closely revealed the following trends:

1. There is a trend to apply the methods of educational research to the organization of high school chemistry.

2. A trend was indicated that the movement in organization is away from the inclusion of more factual material and the development of a second-year high school course to the search for chemistry materials that would have value to all the students.

3. That early in the period there was a trend of articulating college and high school chemistry. Out of this trend came a still later trend of educational studies involving the factors of articulation.

4. A trend broadening the base of the aims and objectives of high school chemistry. The new emphasis is that of meeting social needs.

5. A trend, though not pronounced, was in organizing high school chemistry as an integrated part of the secondary curriculum.

A study of the periodical articles further revealed a number of proposed reorganized high school chemistry courses. These proposals showed definite trends. Early in the period under consideration it was proposed that separate courses be organized for girls and also that courses be organized around the industrial applications of chemistry. It might be added that early in the period there was some mention of organizing the high school course on the project basis, however, more recent

periodical articles suggest the use of projects in the manner of supplementary materials.

Since 1930 there has been a growing interest in the organization of high school chemistry on the unit basis. Various reasons for the unit are advanced but will not be discussed at this point. Other recent course reorganization proposals include: on a contract basis, a pandemic basis, on basic principles, and the most recent suggestion is that two separate courses in high school chemistry be developed. To sum up the findings at this point it would seem right to say that the suggestions for reorganization point toward the social emphasis and larger blocks of material.

The courses-of-study considered in the third step were divided in two groups: (1) public-school courses-of-study, and (2) a miscellaneous group.

The public-school courses-of-study showed two trends in organization. First, that at the beginning of the period under consideration the topical method of organization was prevalent and still continues strongly. Second, that since 1929 there has been a decided swing or trend to the unit organization. During the years 1927–1931 there was some experimentation in organizing the courses-of-study in the form of specific-objectives and science generalization. This cannot be said to have been a definite trend. A further study of the aims and objectives showed that the later courses of study tended to emphasize the cultural aspects of the chemistry course.

In the group headed experimental courses of study was lumped the experimental courses-of-study, the new chemistry workbooks and similar material. It is interesting to note that all this material has been developed since 1933. The experimental courses included those designed as part of a science sequence and also a consumer's course. It was decided that the new chemistry workbooks were in reality courses-of-study employing the newest educational practices and teaching devices. All of this material was organized in units or large divisions of the subject and referred to the individual differences of the pupils.

In the final step, that of examining the chemistry textbooks, forty-five books including revised editions that had been published since 1920 were studied. Two major methods of organization were found—the Topical and Unit organizations. Only six books (including one revised edition) have been published on

the unit basis. That a new trend is developing is indicated by the fact that four of these unit-organized books have been published since 1934. A further study of the contents of both the topical or chapter organized books and the unit-organized books revealed interesting experimentation going on in the matter of chemistry organization—time will not permit a detailed discussion at this point. As in the case of the courses-of-study the aims and objectives of the textbooks were studied in order to determine the trends, if any, that were taking place.

General Conclusions and Summary of Findings

The trends in the organization of high school chemistry may be summarized as follows:

1. Early in the period covered by the study college preparation and the practical applications of chemistry were emphasized. These earlier trends have given way to those of more social significance. This trend is reflected in the later aims and objectives set up for high school chemistry and by attempts to organize chemistry courses designed for general cultural purposes.

2. From a purely descriptive arrangement of chemistry materials of an earlier period the topical method of organization was developed. The topical organization is now being replaced by the unit organization. The unit-organization implies a method of instruction that is peculiar to that form of organization. Various attempts have also been made to apply the project-method and the contract-method to the organization of high school chemistry. This trend may be summed up as an attempt to organize the materials of high school chemistry in such a manner that the method of teaching is implied.

3. Another significant trend in the organization of high school chemistry is the adoption of the scientific method in studying the problems of organization of high school chemistry. The committee procedure was commonly used in the early part of the period covered by the study. Since 1925 the trend has been to studies using the scientific approach.

4. The application of the findings of educational and psychological research to the organization of high school chemistry is another trend developing since 1920. The recognition of individual pupil differences, of problems of text content, of proper methods of presenting the material to the students, and

other similar problems, has led to a general utilization of the findings of the sciences of education and psychology. This is in contrast to the general opinion evidenced during the early part of the period covered by the study.

5. One of the more pronounced trends during the years 1923 to 1927 was that of the articulating of high school and college chemistry. This trend inaugurated by the more subject-minded teachers of chemistry has not solved the more pressing problems of high school chemistry organization. If the organization of high school chemistry is to remain primarily as the basis for college entrance then the content of the high school chemistry course has been well-defined by those responsible for the articulation trend. When viewed in the light of more recent trends this phase of the organization of high school chemistry does not appear to have contributed a great deal and has been one of the more conservative forces.

6. The consideration of the development of the individual student is one of more recent origin. The earlier chemistry courses sought to give factual information to the student assuming that the nature of the material would develop those characteristics peculiar to science. There is a trend now to develop by means of various educational devices certain attitudes, habits, appreciations, and skills in the student.

7. There are also evidences of a trend to integrate the chemistry course with the other subjects in the high school curriculum. This trend is not very pronounced. It is usually referred to in connection with the establishment of a science sequence of courses or the use of chemistry materials in other subjects.

8. The material investigated for the present study falls in two great classes: (1) that representing the theoretical point of view such as various committee reports and periodical articles, and (2) the practical applications as revealed in the courses-of-study and textbook organization. The trend revealed here is the gradual adoption of the various theoretical points of view in the more practical material. This trend was first reflected in the courses-of-study and later in the organization of the textbooks.

It must not be assumed that the organization of high school chemistry is being revolutionized. The organization of high school chemistry is going through a slow process of evolution. The major portion of the textbooks and courses-of-study that are in use today are organized essentially in the same manner

as they were at the beginning of the period covered by the study.

The trends seem to indicate that there is now being evolved a distinctive course in chemistry. This course can be truly designated as or called High School Chemistry. Not an abbreviated General College Chemistry Course for high school pupils.

The lack of a philosophy for the American High School is reflected in the organization of high school chemistry. The question is: shall the course be organized to prepare the student for life or for college?

If the purpose is preparation for college, the content of the course in high school chemistry is well defined. The only problem of organization is that of arranging the materials on the best educational and psychological basis for presentation to the student. This problem is being fairly-well solved.

If, however, the purpose of the course is defined as that of life-preparation the problem of the organization of the high school chemistry course is greater. The pandemic or cultural courses in high school chemistry that have been organized or proposed since 1920 show great diversity as to the basis of organization. The following bases of organization have been used: (1) the course content as set up for college preparation, (2) a course organized on the basic principles of chemistry, (3) courses dealing with the practical applications of chemistry, and (4) a course designed for consumers.

The problems that remain unsolved in the organization of high school chemistry include the following:

1. Will it be possible to develop a single course in high school chemistry that will serve the needs of those students who are preparing for college and those whose formal education will end with the completion of the high school course?

2. Will the next trend in high school chemistry organization be the development of two separated courses in order that the needs of all the students can be met? If so, on what basis shall the pandemic chemistry course be organized?

3. Will high school chemistry tend to lose its identity as a separate subject in the curriculum and become merged or fused as a part of a generalized science program extending throughout the entire secondary course of studies?

DEMONSTRATING EARTHQUAKE WAVES

By Edwin E. Jacobs
Ashland College, Ashland, Ohio

Everyone familiar with earthquakes knows that they travel in waves. These waves start at a point called the centrum and first come to the surface at a place called the epicentrum, a point somewhere above the centrum. These waves are classified as to their speed, effects, and mode of vibration. Now the destructiveness of an earthquake depends upon the violence of the disturbance, or in other words upon the nature of the waves; the greater the amplitude, all other things being equal, the greater the surface effects.

Moreover, the waves are very definitely conditioned by the nature of the material through which they pass. If the material is solid compact rock, the kind found at some depth below the surface (at the centrum), both the amplitude of the waves and the rate of travel will be definitely affected. In this kind of material, all three types of waves will differ in speed and amplitude from what they would be like in the loose soil at the surface where the displacement would be much greater. As is well known during an earthquake, buildings and chimneys have been twisted, roads suffered a lateral displacement of several feet while railroad tracks have been twisted and bent—all surface objects. There is no such displacement below the surface, especially at the centrum in solid rock. It follows then, that to make structures earthquake proof they must, among other things, have their deep foundations laid upon the more solid rock rather than upon the loose surface soil where the displacement is ofttimes very large.

Now while all three kinds of waves (or better, the three modes of travel and their effects) can not be shown by the following demonstration, the surface effects as contrasted with the rock effects can easily be shown. For this purpose, fill a glass tumbler with any kind of cooking gelatin with the usual consistency. The tumbler or dish should have a square edge or shoulder. Now set a tack on its head on the gelatin and a similar one on the shoulder or some other part of the dish. Now, gently tap the dish with some small metallic object. The jelly will be thrown into waves which can be seen in the movements of the tack, while the glass dish will register its vibrations in the behavior of the tack resting on it. In fact, with a bit of skill an

object larger than a tack, say a small nail, resting upon the gelatin may be made to wave and vibrate up to the point of falling while a similar object on the shoulder of the dish, while showing disturbance, will be far from the falling point—all depending on the hardness of the tap delivered to the dish by the demonstrator. Or the differences in the surface effects can be seen by gently striking the table on which the glass is sitting or if the floor shows any vibration at all, as most wooden floors do, the whole system may be thrown into vibration by merely walking across the room. In fact the success of the whole demonstration will very largely depend upon the consistency of the jelly but if all conditions are properly controlled, the effects are very illuminating.

AMERICAN ASSOCIATION OF JUNIOR COLLEGES

Reorganization of the American Association of Junior Colleges, now in in its nineteenth year, has just been effected in accordance with a plan proposed at the annual meeting held in Philadelphia in March 1938.

The reorganization provides for a national headquarters in charge of an Executive Secretary, which was opened September 1, 1938 at 744 Jackson Place, Washington, D.C. Dr. Walter Crosby Eells has accepted an appointment as the first Executive Secretary of the reorganized Association.

Dr. Eells for the past ten years has been Professor of Education at Stanford University. He has just resigned this position to accept the new appointment. For the past three years he has been on leave of absence from Stanford University to act as coordinator of the Cooperative Study of Secondary School Standards at Washington.

Dr. Eells is the author of *The Junior College* which is the most extensive textbook on the junior college movement: of *Surveys of American Higher Education*, and of other books in the educational field. For eight years he has been editor of the *Junior College Journal*. He has participated in various surveys of junior colleges from the Atlantic to the Pacific coast and has written many monographs and articles relating to junior colleges.

Since 1922, Dr. Doak S. Campbell has been secretary of the American Association of Junior Colleges. Increasingly important duties at Peabody College, however, particularly since his promotion to the Deanship of the Graduate School, have compelled him to resign his active connection with the junior college association. During Dr. Campbell's secretaryship the number of junior colleges in the United States has grown from approximately 200 institutions to 553 in 44 states. During the same period the enrollment in these institutions has increased from 16,000 to more than 136,000.

The establishment of a central executive and research office at Washington should have considerable influence in stimulating and guiding the future development of the junior college movement in all parts of the country. Through such an office it will be possible to render more effective assistance to junior colleges wherever located and to assist in the organization of new ones.

BOTANY IN A SMALL HIGH SCHOOL WITH ACCESS TO THE COUNTRY

By Sister M. Claretta Easter
Aquin High School, Freeport, Illinois

There are certain advantages in teaching Botany in a small high school with access to the country which have been overlooked in the consideration of science teaching. Take as an example Aquin High School, which has an enrollment of about one hundred and seventy-five students. Biology is offered as an elective to a sophomore class of thirty-four members. Being a school that is accredited to the North Central Association of Colleges and Secondary Schools, as well as to the University of Illinois, the sizes of our science classes are controlled, according to North Central regulation, by the amount of laboratory equipment available. In compliance with these regulations, then, the number of my biology students is limited to twenty-four. The school is located just at the end of the city limits, our first advantage. A carefully planted campus, the "laboratory" work of the biology students from year to year, furnishes a good proving ground for botanical effort. A walk of two miles brings us to Krape's Park, one of those lovely pieces of Nature's handiwork that hasn't as yet, been "Euclidized" by the WPA. The Forest Preserve of Winnebago County, Illinois, Apple River Canyon, Joe Daviess County, and the Pecatonica and Yellow Rivers can be reached by car in an hour or so. So much for the setting geographically.

Intellectually? The students seem to be the usual sophomore type, full of animal spirits that are easily controlled if mental and physical activities are supplied.

And now the setting pedagogically—unfortunate choice of word, for what pedagogue can resist the temptation to hold forth at length, despite carelessly concealed yawns and restless twisting of his audience.

Permit me at this point to express my views on the methods of presentation of biological material. Every one quotes Agassiz's statement, "study nature not books," and with Doctor Crummy of Pittsburgh I agree that such advice is as true today as it was one hundred years ago. I believe that the basic text, as such, has become a ball and chain for most of our teachers. Being firmly convinced that dry book recitations and drier specimen were actually a contradiction of the title of the course

itself, I daringly announced, "No text required for biology this year." An account of the results would be out of place in this paper, but they were all that you might expect. The deed was drastic. The avalanche descended but did not completely engulf the perpetrator. With such convictions the field, a boundless laboratory, was the logical alternative, in which to find, observe, and live life. No monotonous routine here, surely.

High school biology should be of the inspirational type. To do this the teacher himself must be enthusiastic. There are so many ways of interesting students in biology that one must conclude that textbook writers who proclaim that the high school student is a "self-centered animal" have never taught live botany.

I plan my course on the theory that every student is a born naturalist with unpredictable latent possibilities for scientific development. Imagine giving a ten year old boy his choice between going to the circus and reading about it in *From Rome to Ringling*. In all science the printed page should be secondary to the laboratory, field, and clinic. We remember poorly the printed text, and best our actual experiences.

I am of the same opinion as Mr. Arthur Parker of Rochester University who says, "Pedagogically, teaching by means of objects and experiments is sound. It is highly effective also since it makes realities emerge from what might have been only words. Contact with reality builds clear concepts and judgments."

There is nothing that can take the place of the actual specimen. Pictures, lantern slides, models, all are valuable but they only partially fill the need. The best way to accomplish this end, is to build up a teaching museum. In this museum you want teaching material, not a miscellaneous collection consisting of stuffed truck that some fond but tidy housewife will no longer give house room to. The modern tendency is to junk the assorted deer heads, mounted fish and so forth and develop a collection of permanent demonstration material which will be useful in the daily routine of teaching. An appropriation for such material is difficult to obtain and the laboratory fee barely covers the current requirements, but a period of years plus a well thought-out plan may turn the trick.

Someone has used the expression, life history method of teaching biology. This it seems to me is a satisfactory means of approach. Typical representatives of each phylum, class and

even order are at hand for collecting. So, if we can turn out students who know something of the life histories of each phylum of animals and plants, we have attained the primary end of elementary biology teaching—namely to introduce students to their animal and plant neighbors and make them familiar with their home life.

To facilitate your following this discussion I shall make the division of my course a seasonal one, bearing in mind that restricting phrase in my title "with access to the country."

Fall, a season of plant preparation for protection during the long cold months to come, offers an opportunity to explain the deciduous and non-deciduous phenomena, autumn coloration, fruit coverings that will guard the seeds during the dormant stage and various mechanisms for seed dispersal. It is at this season, too, that we make a detailed study of trees, in their full dress attire, often times photographing them in what is without doubt their best pose.

Accordingly our first field trip is a tour of the campus and immediate environs. At this time, too, we collect leaves for a campus herbarium which is arranged at a later date when further collections in the neighborhood and a detailed study of leaves have been made. It is on this first trip that the students are advised of the need to observe, remember, and compare, since subsequently they must explore, discover, and proceed, under their own initiative. Each succeeding trip is a carefully planned excursion into Nature's laboratory and is followed by an examination over the things encountered along the way. This I do by oral quizzing while in the field rather than by taking the joy out of the work by the warning announcement "be ready for a test when we return!"

At the end of the second week a hike to the Pecatonica River is in order. This trip, too, is chiefly exploratory. If we have had rain during the week, then the suggestion is made that after a rain is a good time to look for slime molds. Sometimes we are quite successful in our finds, but always a piece of decaying wood is brought into the laboratory, and covered with a bell jar. Within comparatively few hours the plasmodium spreads over the inner surface of the jar in an intricate vein-like network and the movement of the protoplasm is easily demonstrated. For a period of two weeks or so we discuss informally anything that may have been noted in the field, referring to the numerous botanical references in our library.

Next a trip to the florist's greenhouse is taken, primarily, for the purpose of observing the habitat of a common algae, *Vaucheria geminata*, which grows in thick green felt-like patches on the flower pots. This is generally in the vegetative condition. We bring some to the laboratory to note the formation of oogonia and antheridia, which may be induced in bright sunlight by using a two to four per cent cane sugar solution.

It is now the appropriate moment for consideration of the unit of study which will be presented at the convention later in the year. A list of subjects are submitted by the students and from this, each chooses a topic in the field in which he is most interested. He is to make himself an authority on the subject and pretend that he has made this a research problem over a number of years. The student is then a delegate from the state which would give him access to the necessary specimen for his project. For example the lad who chooses Conifers would represent Canada or some northern state; Marine Algae, the east or west coast; Cacti, Mexico; and Field Identification of Trees, Illinois, which is noted for its numerous varieties. From now until May any extra time available is devoted to collecting and studying material for these units. Further details of the convention will be given later in this paper.

Proceeding on the advice of Thoreau, "Winter is the time to take a census of the woods," with the first snowfall we again fare forth to one of our nearby woods. We find that in the winter many things may be studied at leisure which later will be growing rapidly and changing in appearance day by day. This is an opportune time for the study of plant galls that are made by a variety of insects. Some of the galls found in winter will be dry and empty and if one is examined carefully the hole through which the insect emerged will be seen. Others are still serving as insect homes and contain the hibernating larvae or pupae. We still have a great deal to learn about insect galls but the casual student can have the satisfaction of learning to know the names of the more common kinds. Galls are found on almost all plants and may occur on the leaves, stems, flowers, or roots. Golden rod, willows, poplars, roses and oaks, also furnish interesting specimens.

A surprising amount of botanical work can be done on winter field trips even when the ground is covered with snow and the temperature low. The trees are a study in themselves, and some, because of their distinctive manner of growth can

be recognized almost as far away as they can be seen. On the whole, accurate identifications are no more difficult in winter than in summer.

Many wild seeds and fruits persist throughout the winter and can be collected. Lichens are easily collected and a little search in sheltered ravines will usually bring to light living mosses and woody fungi of one or many years' growth. Many herbaceous plants grow to some extent throughout the winter. Scraping snow and dead leaves aside reveals a surprising number. The basal rosettes of leaves, which some perennials produce, usually appear in the late autumn, but continue to grow under the snow.

One of these winter trips affords opportunity for studying living fungi. We bring back with us a small basket of moist soil containing rotting leaves. We line the bottom of a small battery jar with wet sand. To this we add the moist soil and leaves and on the surface lay pieces of half-decayed wood and bark which we had collected in the woods. A glass cover is placed on top of the jar, and the whole set in a warm room, where some light, but not direct sunlight is available. Then they await developments with great expectancy. This average culture yields several growing fungi and even some fairly large sized mushrooms. The fascination of the unexpected always proves a source of interest for several weeks. Students learn much if required to explain the reason for the presence of the fungi, how they grow so rapidly, what kinds they are, and what their spores are like.

With a piece of horse manure that delightful fungus, *Philobolus*, commonly called the squirting fungus, is demonstrated. All of you are familiar with it, but to the students, the bull's eye accuracy of the spore dispersal mechanism is a source of wonder.

Mushrooms collected at this time are preserved by properly drying them and orderly arranging them in boxes. They naturally are reduced in size or became warped in many cases, but still preserve all the botanical characters. Some too are preserved by the formal-acetic method.

Later in December or January when the ponds and creeks have frozen over, the boys armed with ice picks take particular delight in locating masses of algae by the characteristic green tinge of color in the ice. Most localities yield an abundance and variety of both unicellular and multicellular members of this

group. Most of the members are independent but there are also epiphytic, endophytic and saprophytic species.

Vaucheria geminata begins to appear late in the fall around springs and pools. At the beginning of winter it has attained considerable growth of the filaments. Winter season comes on it in the vegetative state and in shallow pools it freezes hard. Cakes of ice containing this plant may be put into cold water and within a few hours after melting may be brought into a warm room. Several days later, zoospores literally cover the surface of the aquarium and can be scooped off in all stages. If the spores are left they will reproduce new plants which can be made to produce zoospores any time during the year. Later, on the spring trips, attention will be called to these same larger forms which are readily recognizable with the aid of the microscope. The fair weather naturalist achieves no victories worthy to be sung, but he who fares forth when wintry winds blow will make discoveries.

During the very cold weeks of January and February we do considerable microscopic work. We count and arrange our collections of the previous months. Habit groups of such types as lichens, mosses, and ferns; sets of stems, leaves and seeds are arranged.

One of the fascinating phases of the life history of the fern, the opening of the sporangium and the catapulting of the spores is demonstrated. The whole process takes less than five minutes, the demonstration is striking and it invariably provokes much discussion of the mechanism involved in the release of spores.

The woodland mosses that were collected in October are used now to construct a woodland terrarium. Salamanders come in the coal cars from the south and thrive well in the terrarium. Cactus plants are secured from the florist or a biological supply house, for a desert terrarium, for purposes of comparison. The aquarium, too, is begun.

A study of the propagation of plants is made. We use cuttings from the geraniums, coleus, wandering Jew and ivy from the school flower boxes. Begonias, too, are easily propagated by cutting the leaves crosswise and planting in sand. Potato eyes are potential buds that develop into new individuals when planted. The leafy top of a pineapple left to dry for several days and then planted will develop into a new plant. Thus three types of plant propagation are observed.

Work on our garden show is begun in March. These are miniature gardens, either formal or informal, planted with grass and small flowers, to which is added the garden furniture that suits the individual's fancy. We have had rock gardens with running streams (made possible by a siphon arrangement), a game preserve of a large estate, a truck garden, a city front yard, and even a New York tenement garden. A prize is awarded and the best results are in demand for display at the public library.

One year we had a flower show instead. At this the students prepared displays of correct arrangement of flowers or other plants for breakfast, luncheon, and dinner tables; children's party tables; invalids' trays; fireplace mantles; hall entrances and living room end tables.

An annual pet show, a guinea pig nutrition experiment, and preparations of skeletons are other activities in which we indulge but details are not apropos here, since the restriction was "plant study."

This year we plan to vary the garden idea by having a garden show outside. We expect to plant three *Lombardy Poplars*, a privet hedge, some bushes of *Spirea Van Houtie*, iris rhizomes, gladiola bulbs, sweet peas, and calendulas. The ground will be prepared by the students before the scheduled date but the actual planting with scientific explanation of the why and how will be given in the presence of the parents and others interested in viewing our garden show. It distresses me when I attend the Freeport and Chicago Flower Shows to see the extravagant disregard for plant life that is evidenced in the reckless manner in which trees and shrubs of many years growth are ruthlessly cut down to form a setting or background for the floral display. So, we hope by our little show to partially counterbalance by planting the damage they do by uprooting.

The arrival of spring arouses the interest of the students in an early call at the old hunting grounds. At this time we find considerable supplies of *Spirogyra* and *Oedogonium* in their purest state. In late spring quiet shallow nooks are usually green with *Euglena viridis* and the jelly-like balls of *Nostoc* floating along the edges. Many of the general Chlorophyceae are easily kept in the laboratory in the fruiting, as well as in the vegetative condition.

By this time, May, preparation for the scientific convention has reached completion. This convention has been an annual

affair for the past five years so competition is keen and enthusiasm runs high. The procedure is exactly like that of the A.A.A.S. Advance announcements and copies of a tentative program are sent out to the parents. A science teacher from a nearby college is invited to speak on the program and such information as train schedules, taxi service, and hotel rates are sent to him in advance. This information is also sent to the student's friends living in neighboring towns who sometime attend the sessions.

A publicity committee provides articles for the daily newspaper and furnishes posters for display throughout the business district. In fact, we follow in detail the suggestions of a pamphlet compiled by the Chamber of Commerce of the United States of America, entitled Convention Work. Committees are appointed for ordering badges, registration cards, signs, and other convention paraphernalia; arranging for committee, luncheon, banquet and reception rooms. Adequate convention and meeting rooms and space for exhibits in the auditorium are also provided. Delegates are all duly registered outside the meeting room where complete registration equipment, is set up. The convention bureau makes arrangements for the entertainments of visitors, an excursion trip to Apple River Canyon, a theater party and banquet being the usual forms.

The program committee aims at a balanced program—topliners at the beginning and at the end—having definite keynotes. The names of the leaders of discussions at Round Table meetings are properly posted. The speakers are given a definite understanding as to time and place of appearance, and length of desired address. This program is printed and ready for distribution on registration. It contains an orderly chronological schedule of events giving definite hours for:

a. Opening and closing of various sessions
b. Addresses and discussions
c. Group meetings
d. Social events
e. Hours of explanatory tours of the exhibits.

Each delegate, as I have said before, is allotted time on the program for a lecture. At certain other hours each is to be found at his exhibit space, ready to give an explanatory discourse to any one interested in the display.

This account is growing quite long and therefore to avoid reaching that stage previously mentioned of ill-concealed yawns

and restless twistings I shall conclude with a list of some of the convention projects.

Protective Adaptations	Study of Embryonic Development of the Chicken
Foods Used for Furniture	Preparing Skeletons of Mammals
Fruits	Seed Dispersal
Reproduction in Plants	Woodland Species
Plant Colors	Plant Propagation
Medicinal Plants	Tree Photography
Weed Collections	Leaf Collections

Such then are the possibilities for science in a small town.

Summary

Aquin High School has an enrollment of about one hundred and seventy five students. Biology is offered as an elective to the sophomore class. A carefully planted campus, the "laboratory" work of the biology students from year to year furnishes a good proving ground for botanical effort.

Textbook teaching ignores the first tenets of scientific procedure in that it fails to produce the object under discussion. Accordingly I abolished the text for a year as an experiment. The results were gratifying. Thus the field, a boundless laboratory, becomes the logical alternative in which to observe and live life, hence there is no monotonous routine.

Modern science owes its progress to the fact that it has sought truth by direct observation. Therefore, a biology course should open up to the student the fascinating field of general biological speculation and investigation. We remember poorly the printed text, but best our actual experiences.

There is nothing that can take the place of the actual specimen. The best way to accomplish this end is to build up a teaching museum. An appropriation for such material is difficult to obtain but a period of years plus a well thought-out plan may turn the trick.

Life history method of teaching biology seems a satisfactory one. By such a method we attain the primary end of elementary biology teaching—namely, to introduce students to their animal and plant neighbors and make them familiar with their home life.

The division of my course is a seasonal one. Fall offers opportunity to study preparation of plants for the long winter, the falling of leaves, autumn coloration, fruit coverings, and seed

dispersal. Part of this is done right on the campus. Students are counseled to proceed under their own initiative. Quizzing is done in the field; not formally in the class room.

Trips to the Pecatonica and a florist green house are part of the fall work. It is in October or November that subjects for the convention are submitted by the students, each choosing one field in which by his research work he will become an "authority." Each student becomes a delegate to the convention representing the state which would most likely furnish, in abundance, specimens for his project. For example, Conifers—Maine; Cacti—Mexico; and so forth. All extra time is devoted to this unit of study.

Winter—the first snowfall finds us again in the woods studying insect galls, trees in their winter dress, wild seeds and fruits, lichens, mosses and woody fungi. Cakes of ice from ponds containing algae are brought into the laboratory and the production of zoospores is observed.

During the very cold weeks of January and February considerable microscopic work is done. Collections of previous months are mounted. Terraria of the desert and woodland type are assembled. A study of plant propagation is made at this time, too.

Work on our garden show is begun in March. These are in miniature, either formal or informal. Rock gardens with running streams, game preserves, truck gardens, city front yards and New York tenement gardens are some of the usual entries. These are displayed at the Public Library.

Garden show idea varies. One year we prepared displays of correct arrangement of flowers for various occasions. Another an outside show in which we planted trees and shrubs.

The arrival of spring arouses a desire to make an early call to the old hunting grounds. We note which trees blossom first, the wild flowers, and medicinal herbs.

Preparations for the scientific convention reach completion in May. An annual affair, the procedure is that of the A.A.A.S. A scientist from a nearby college is invited to speak, lectures are given by the students, round table discussions are scheduled and explanatory tours of the exhibits are made.

Thus the convention serves as a complete review for the biology students, a revelation for many outsiders and an incentive for those lower classmen who are doubtful of their electives for the coming year.

DERIVING THE QUADRATIC FORMULA

By Walter I. Murray
East Pulaski School, Gary, Indiana

Ingenious methods for the solution of quadratics have been offered since 500 B.C. Aryabhata, Brahmagupta, Mahāvīra, Al-Khowârîzma, and Vieta (1590 A.D.) made contributions of varying values. According to Dr. Vera Sanford, Stevin was one of the first to use a single formula. We are all familiar with the treatment given ordinarily in high school algebra.

After studying some of the modern methods, I am submitting the following method of developing the formula to be used after a simpler treatment has been given and the students thoroughly understand the meaning of quadratics. I feel that this is an especially valuable method for rigorous treatment with more advanced high school students.

The principle used is that of elimination of a middle term which Cardan used in his solution of the cubic. A substitution is made and the algebraic processes are carried out.

Given the general quadratic:

$$ax^2+bx+c=0$$

Let $$x=y+h$$

$$a(y+h)^2+b(y+h)+c=0$$

$$ay^2+2ayh+ah^2+by+bh+c=0$$

$$ay^2+y(2ah+b)+ah^2+bh+c=0.$$

Condition that y be eliminated is

$$2ah+b=0$$

then $$h=-\frac{b}{2a}$$

$$ay^2+a\left(\frac{-b}{2a}\right)^2+b\left(\frac{-b}{2a}\right)+c=0$$

$$ay^2+\frac{ab^2}{4a^2}-\frac{b^2}{2a}+c=0$$

$$ay^2=\frac{-b^2}{4a}+\frac{2b^2}{4a}-c$$

$$ay^2=\frac{b^2}{4a}-c$$

$$= \frac{b^2 - 4ac}{4a}$$

$$y^2 = \frac{b^2 - 4ac}{4a^2}$$

$$y = \frac{\pm\sqrt{b^2 - 4ac}}{2a}$$

But $x = y + h$

$$x = y - \frac{b}{2a}$$

then, $$x = \frac{\pm\sqrt{b^2 - 4ac}}{2a} - \frac{b}{2a}$$

$$= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

LABORATORY TEACHING IN GEOLOGY[1]

By Robert H. Mitchell
Muskingum College, New Concord, Ohio

Education is not static and rightly so. Educational advancement as well as all other types of advancement must come from discontent with existing methods and from experimentation with other types of procedure. Frequently teachers try new methods and procedures and then pass judgment on them in terms of "it seems to me." Such experimentation is not scientific.

Being dissatisfied with the method of laboratory instruction in Geology then in use at Muskingum College the author, several years ago, undertook a study of the relative teaching value of the method then in use and of two other methods which were brought to his attention.

The method which was in use at the time the study was begun might be termed the Lecture-Written Response Method. The student was given by lecture, assigned readings or both, all the information necessary for working out an exercise. The papers

[1] *A College Looks at its Program*, Muskingum College Faculty. Chapter IV describes fully the methods and procedures used and gives the statistical tables upon which the results were based.

were collected at the close of each laboratory period, corrected and returned at the beginning of the next period. During the laboratory period the instructor moves about the room volunteering aid, asking questions and giving any further instruction needed.

A method which might be called the Individual Conference type which was a modification of a method used in Plant Pathology laboratory at Cornell University[2] was tried as a possible improvement on the method just described. In this method the students used a manual which gave the information necessary for the working of the exercise and they were expected to study the manual before coming to the laboratory. Each student was expected to complete a certain number of exercises during the semester. Some of these exercises were required and several were selected by the student from a given list.

During the laboratory period the instructor gave no unsolicited aid but students might ask questions after they had exhausted all available authentic sources of information. The aid given was never direct but was a series of questions designed to lead the student to a solution of his problem. When the student had completed the exercise to his own satisfaction he might elect to take a conference quiz on the work. Before he knew his quiz grade he might elect to take or not to take the grade he earned. If he took the grade he proceeded to the next exercise but if he elected not to take the grade he might work on the exercise again and take a new quiz at a later date. The final quiz was used for grading purposes and previous attempts were not counted.

The Lecture and Discussion type was also used as a possible improvement on the Lecture-Written Response type. In this type of work the instructor and students worked on an exercise together after the manner of a discussion group. Frequent tests were given in order to obtain a grade for the students.

The laboratory exercises used in all the groups were identical with the exception that in the Individual Conference method the students were allowed certain choices which were not permitted in the other two methods. In some cases he might choose to work on an exercise which was not available to the other groups.

The laboratory grades for all students were based on their

[2] H. H. Whetzel, "An Experiment in Teaching." *Scientific Monthly*, August, 1930, pp. 151–62.

daily laboratory work, their field work and a final examination. The work was similar for all groups and all tests were of the objective type, the only variation being in the method of procedure.

Comparable groups of students, paired on the basis of six-weeks' grade-point ratio, sex and intelligence test percentile rating, taught by the three methods were compared in order to determine which type of instruction yielded the best results. Before the groups were compared the adequacy of the pairing was tested by similar pairing within each group on the basis of the same traits and it was found that the experimental control conditions were satisfactory.

The data thus obtained indicated that the Individual Conference method was better than either of the other two methods and that the Lecture-Discussion method was inferior to the other types.

It should be kept in mind that these findings apply to conditions as they exist at Muskingum College and may or may not be valid for other teachers or teaching "contexts."

This study is not an exhaustive research, consequently no attempt was made to try out these methods under conditions other than those which exist at Muskingum College. However, its value is apparent in that it calls attention to the fact that the same subject matter may be presented by several different methods and suggests the possibility of comparing scientifically the relative value of the various methods.

The same procedure may be used regardless to subject matter, to determine which of several methods of teaching are most valuable under a given set of conditions. It is not improbable that such comparisons might show that under a given set of conditions one method might be best while under another set of conditions another method might prove more valuable.

This procedure is susceptible to further refinements which are applicable in the field of secondary education as well as to education on the college level. It is our hope that this report will stimulate others in the field of education on both secondary and college levels to try to solve their educational problems by scientifically controlled experiments rather than by the "hunch" or "it seems to me" procedure.

When you change address be sure to notify Business Manager W. F. Roecker, 3319 N. 14th Street, Milwaukee, Wis.

SHOULD WE HAVE NATIONAL TEXTBOOKS ON CONSERVATION TEACHING?

By Charles W. Quaintance
Cornell University, Ithaca, New York

Money for Conservation Textbooks

Conservation education will be project number one with the surplus derived from the sale of wildlife poster stamps during National Wildlife Restoration Week. This is the statement made by that leader of American conservation, "Ding" Darling, at the recent North American Wildlife Conference at Baltimore. He said that for $30,000 we ought to be able to get national textbooks on conservation, written by experts. These textbooks would be written on three educational levels. The production of sound moving picture films was suggested as an additional project beyond the textbooks. These "talkies" might show the Gobi desert and Palestine, the "cradles" of mankind, now bereft of natural resources; and the "jungle" town in California in which the huts are occupied by thousands of people evicted from our dust bowl.

Both of these ideas are splendid. It is proper, nevertheless, for those of us who are to educate, to ask whether the idea of national textbooks would be adequate for teaching conservation to our youth. We should have a systematic, integrated training in conservation for our young people. We need to contact children before they are conditioned to familiar prejudices. Can this be achieved by national textbooks?

It would seem at first sight that the amount of money estimated necessary by Mr. Darling would give a tremendous impetus to the teaching of conservation. However, we recall a somewhat similar sum being spent by the Laura Spelman Rockefeller Fund on the Coordinating Council of Nature Activities. This was to further the idea of sponsoring national reference works in nature study, and was as laudable as the proposed texts on conservation. The only printed publications which grew out of five years of this work were *The Romance of Your Birthstones, Mushrooms of Field and Wood,* and a bibliography of nature books. It would be unfair if these works were listed as the only results of the subsidy, but we offer this as an instance that making a sum of money available does not necessarily guarantee reaching the goal we seek.

I. Are National Textbooks Advisable?

Local conditions differ. Those of us from the west who attempted to do anything with the Bird Study requirement of the Boy Scouts, found at once that the merit badge pamphlet simply did not meet the needs of the boys in California and Arizona. This was true also of the forestry handbook. It was not that these merit badge pamphlets were not prepared by experts, or that they might not have sufficed for the eastern Boy Scouts, but that they did not touch upon conditions in the western states.

Now, what are our national resources but birds and mammals, forests, rangeland and soils, aud waters? How enormous would any textbook be which would attempt to cover all of the major resources for all of the diverse regions of the United States! Even college texts do not attempt to do this.

The national resources of two western states, Arizona and Oregon, for instance, are very different and a textbook written for one would not be at all adequate for the other. Some of the resources typical to Arizona are the giant sahurao, creosote bushes, greasewood, sagebrush, javelinas, pyrrhuloxias, phainopeplas, Merriam turkeys, Gambel quail, pocket mice, pack-rats, intermittent streams, caliche soil, and copper mines. How many of these are familiar to the eastern student? How many even to Oregonians? In Oregon, on the other hand, the streams are more permanent and lava plays a great part in the soils of both mountain and plain. Among the biota there are conies, moles, and marmots, and lodge-pole pine, as well as white pelicans and Steller jays. Those in the East know how little a textbook dealing with these resources would mean to them. Conversely, the plants and animals, the soils and streams of the New England states would be of little value to grade-school students in the western states, or even in the southern states. The mention of these diversities of our resources is made at the risk of saying the obvious, but it is this obvious difference in the regions of the union which is being overlooked in the planning for a national textbook for elementary and intermediate grades.

I grant that in a college course in conservation we are justified in giving examples from far and wide; mature students should be conversant with problems that vitally affect them as citizens and taxpayers. But the basis for this broad knowledge must first be laid by the study of familiar resources in the immediate

environment of the student. It is a platitude to say that conservation should begin at home, but it is a platitude we can not afford to overlook.

Those of us who heard Darling condemn laboratory biology as being inadequate to give the proper conception of living things can heartily concur. So much of the pre-college science, from the elementary schools on up, falls into this category of teaching about dynamic organisms from textbooks or from pickled specimens. An example will serve to illustrate the point. A practice teacher in high-school biology in a western school system arranged with his class to take a Saturday field trip. Dr. Charles T. Vorhies, field naturalist and zoologist at the state university, was obtained to guide the trip. At the forest experiment station Dr. Vorhies stood by the fence which kept cattle out of an enclosed area that was lush in grass, in sharp contrast to the area outside which was grazed to the ground. He turned to the children and said: "Funny the rain didn't fall outside of the fence!" And then began one of the most stimulating experiences those children ever had, an experience in the necessity of conservation of soil and forage, and of the part which the burrowing rodents and the insects and plants of this region played in the actual environment which is the heritage of their own community.

Long ago, Liberty Hyde Bailey made a statement regarding nature study which is certainly applicable to the study of the conservation of natural resources, especially since nature study is background material for the knowledge needed for conservation. He said (*Cornell Nature-Study Leaflet*, 1904, p. 11): "Nature study, as a process, is seeing the things that one looks at, and the drawing of proper conclusions from what one sees." Every member of our Committee* engaged in the national survey of conservation education urges this type of personal experience as essential to developing proper conservation attitudes. Building upon such personal experiences with local resources the child can create a philosophy of conservation for his own community. A textbook describing or picturing erosion in general, or wild animals in general can not have the effect that the actual contact with local conditions will have. The precarious status of the Brown Pelican in Texas is of little import to a New York child who has never seen a Brown Pelican

* Conservation education survey sponsored by American Nature Association fellowships through recommendation of Arthur Newton Pack, and under the leadership of Professor E. Laurence Palmer.

or any of its near relatives. On the other hand, the plight of the fringed gentian is very real to a New York student whose teacher has shown him this rare flower along the bank of a pond. Let us stress the study of the things at hand, the "acres of diamonds," in our own back yard.

II. Are Local Texts Adequate and Unbiased?

Of course, the exponents of national textbooks in conservation (for lower grades) would raise a counter question about local textbooks or source books, and it is a perfectly legitimate one. Can we avoid indoctrination if the responsibility for the preparation of books is delegated to local authorities? This phase of the problem is admirably presented in an article, "Conservation?" (1937 *Wisconsin Journal of Education*, December: 200–202). The author, Mr. E. M. Dahlberg, formerly a member of the Wisconsin department of conservation, is now a teacher of biology in a Wisconsin High School, and consequently should be qualified to speak with some authority when he asks whether our conservation teaching will be based on the laws of natural history or on current practices of the conservation commissions or federal bureaus.

A great number of local (i.e., state) tentative programs are reviewed and investigated through personal visitation by members of our committee. We frankly admit that some of the material now being given to teachers has a tendency to teach current practices, and hence to indoctrinate rather than develop clear, critical thinking. An otherwise excellent bulletin of the Michigan department of conservation, *Three Boys Go Camping*, stresses predator control whereas even the field experts, men like Paul Errington and Wilson, on the basis of scientific wildlife research, are questioning predator control as practiced in some areas. To the credit of the Michigan department of conservation, it should be said that the January, 1938, issue of their journal contains a notable contribution on predation by Hoyes Lloyd, superintendent of wildlife in the National Parks of Canada.

In another state the department of conservation, in cooperation with the department of education, has written a tentative outline for study of the resources of that state. County committees are asked to criticize this outline in use. Each county superintendent of schools may appoint a committee of five teachers, and the president or secretary of the local sportsmen's

club; also, the conservation commission assigns a member to the committee. The tentative bulletin of this state is excellent as a beginning, but it is lacking in any study of soils or waters, and the committee set-up has no provision for the addition of men representing these resources. Now it is true to a large extent that sportsmen in this state are underwriting these projects. But it is also true that the wildlife about which they are sincerely concerned is dependent, as Dr. Walter P. Taylor of the U. S. Biological Survey has so aptly said, in the last analysis on soils, waters and forest. Wildlife enthusiasts, young and old, will need to begin conservation measures with these basic resources if they are to make any permanent contribution to the preservation of native wildlife.

Of course, "Look what the sportsman has done so far," is a common rallying cry. Mr. Gabrielson, chief of the Biological Survey has answered this very pointedly at the recent wildlife conference: "Since the first game laws were passed in this country, it has been the American custom to make these laws and regulations chiefly in accordance with the wishes and views of the majority of the men who hunt . . . It is only within recent years, and then usually when wildlife seems to be reaching the vanishing point, that a different philosophy has come to prevail . . . " (as quoted from *Baltimore Sun*, February 18, 1938).

I do not wish to disparage the fine work being done by the conservation departments and by interested sportsmen, but sportsmen everywhere are not equally capable of restoring or conserving wildlife. In one state covered by our survey members where there has been no open season on deer in a large part of that state for years, the game commission suddenly recommended, without making any adequate population study, that there be a four week open season on deer. What can the conservation commission of that state submit to their teachers about principles of conservation when they do not understand the first principles themselves?

The Dilemma in Conservation Education

It has been pointed out in the previous paragraphs that because of the great diversity of natural resources in our country, a national textbook on conservation (for use in the pre-college years) does not seem advisable. On the other hand, the pitfalls of conservation units prepared locally have been em-

phasized. In spite of the possible dangers of the latter method, we are familiar with several splendid locally prepared manuals. In New York we have the *Cornell Rural School Leaflets* with their stress on local materials. Some of these leaflets, such as those on "Save the soil," "Are they vermin?" and "Conservation," are written with conservation as the central theme; in the other leaflets this phase may be stressed to a greater or less extent. Similarly, in Iowa, Dr. George Hendrickson at Ames has put out several bulletins of a parallel nature. In California there is a monthly bulletin, *The Science Guide to Elementary Schools*, which has presented two issues devoted to conservation, one on soils and one on water. In all these cases the materials are written by thoroughly trained field men who are competent to handle the subject.

In other states, the conservation commissions have been doing excellent work for the field of conservation as a whole. Ohio has prepared a mimeographed manual of her natural resources and has already prepared tentative outlines at three levels, elementary, intermediate, and junior-senior high school on the teaching of soil erosion and of water distribution. Florida has printed units written by experts in the several fields. Tennessee has a trained biologist who visits the schools, taking illustrative material, specimens and films with him, meeting with the teachers at county get-togethers, and writing materials for temporary consumption. The Tennessee commissioner has called together representatives from the TVA, the U. S. Biological Survey, the forest service, the state supervisor of elementary education, and other educators to study the problem of how best to present the material. The result of this conference is that units on conservation are to be written by teachers whose individual programs are noteworthy; these units are to be reviewed by the Peabody curriculum study. Both Wisconsin and Utah have bulletins which are laudable as attacks on the wide-open field that conservation presents. It is not our purpose here to make any comparison of the different programs available, but merely to point out local programs which are definitely under way and which give promise of an intelligent and broad treatment of the problem.

There is no intention in this article to criticize the allotting of funds by the General Wildlife Federation for conservation education study materials; rather the object is to suggest that such funds be wisely apportioned to subsidize local efforts of

proven value. In spite of the drawbacks involved in the preparation of units for conservation education in local areas such as the states, it looks as if the way to progress in this field lay here, rather than in the writing of textbooks on a grand, national scale.

SOME EASY PROJECTS IN CHEMISTRY

Project 4, Silvering a Mirror for the Musical Show

By Kienast Smith
Senior High School, Orlando, Florida

When we were getting the stage ready for "The Mikado," it was decided to have two spotlights, one at each end of the stage and well in front. These lights were concave mirrors, silvered on the back, with a lamp in front of each one. The back of one of the mirrors was in good condition, but the other was in bad shape. My problem was to resilver this mirror so that it would serve as well as the other one.

The first thing to do was to remove all of the material from the back of the glass. This was done with warm diluted nitric acid. When the material was all removed, the glass was washed with hot water and soap and rinsed with distilled water. I was careful not to touch this cleaned surface with the fingers.

For silvering, two solutions were used. The first was a solution of silver oxide and the second was a reducing solution. These had been prepared for use according to the Brashear process. A small bowl of such size that the mirror would just fit into it was filled nearly full of a mixture of the silver oxide solution with about one-tenth as much of the reducing solution. The combined liquids were well stirred and then the mirror, convex side down, was carefully lowered into the mixture. I let the mirror remain in contact with the silvering solution for perhaps two or three minutes, until a good deposit of silver had been made on the convex surface. The glass was then removed, rinsed carefully with distilled water two or three times and dried by air contact only. When dry, the silvered surface was dipped into some dilute shellac which soon dried to form a protective coating over the silver. The front of the mirror (concave side) was carefully cleaned and the mirror placed in position for use as a spotlight. It worked perfectly.

Solutions for silvering glass are prepared as follows:

Solution A.—Silver Solution. Dissolve one gram of silver nitrate in 100 cc. distilled water. Add ammonium hydroxide (dilute) cautiously until the precipitate which first forms just dissolves. Now add one-half gram of solid potassium hydroxide dissolved in 50 cc. distilled water. A brown precipitate forms. Very cautiously add ammonium hydroxide again until the brown product barely dissolves. Don't use too much ammonium hydroxide.

Solution B.—Reducing Solution. Dissolve 40 g. cane sugar in 350 cc. distilled water, add 87.5 cc. ethyl alcohol and 1.5 cc. concentrated nitric acid. The longer this is made to stand the better. It should stand at least a week. When ready to use, make up to 500 cc. with distilled water.

VISUAL DEFECTS

Approximately 300,000 students in American colleges and universities—or nearly 25 per cent of the entire enrollment—are handicapped in their studies by serious visual defects, it was disclosed in a recent report of the Eye Health Committee of the American Student Health Association.

Surveys of students' vision reveal that the principal defects are astigmatism, farsightedness, and a lack of eye coordination, according to the report, prepared for the Committee by Anette M. Phelan, Ph.D., Associate in Health Education, National Society for the Prevention of Blindness. R. W. Bradshaw, M.D., Director of Student Health at Oberlin College, is chairman of the Committee.

Pointing out that the discovery and correction of visual defects is of vital concern to college administrators, the report urges a full ophthalmic examination for all students. It calls attention also to the fact that not only do students enter college with twice as many visual defects as their contemporaries who go into industry, but that one in six entering with presumably good vision will need glasses or treatment before graduation, and one in eleven will suffer a serious loss of visual acuity.

The Eye Health Committee, cooperating with an advisory group headed by W. L. Benedict, M.D., of Rochester, Minn., appointed by the American Academy of Ophthalmology and Otolaryngology, has undertaken a study of the vision appraisal and supervision of college students. The investigation includes an evaluation of available methods for early detection of students with visual defects, a system of uniform records so that comparable data may be assembled, and plans for securing ophthalmic supervision of students needing attention.

"It is hoped," the report says, "that medical directors of the student health services in the colleges and universities throughout the country will actively interest themselves in the eye health problems of college students and lend their assistance to the Committee's efforts to find a solution."

PREHISTORIC MATHEMATICS?

By Raymond L. Krueger
Wittenberg College, Springfield, Ohio

Ab and Ug were cave men who lived many years ago, away up in the mountains. They could not even talk, let alone read or write. But one day Ab lamented his sorry plight, for it was not always easy to express himself with his hands by sign language, and besides, it tired him out, especially when he was arguing extensively with Eek, his wife. So he planned a new method of conversation by means of different grunts. He joyously ran to his old school fellow, Ug, who caught on to his system right away. Then ensued a frightful session of grunting. Words were invented and forgotten, only to be reinvented in the twinkling of an eye. Ug actually shook himself out of his leopard skin in his enthusiasm.

Ab would point to a huge war club and grunt, "clubb," and it sounded so much like the way an enemy's head cracked that Ug immediately repeated, "clubb." Ug softly caressed a bear skin he was sitting on and said, "furr," imitating the purring noise he so many times heard the lions make, when they had just filled up on one of his cousins and were walking away, happy. Ab uttered, "whiffe, whiffe," for he smelt the tantalizing odor of snake marmalade, which his wife had been cooking, and just then they saw Eek in the doorway, holding the steaming victual. Ug clapped his hands and shouted, "whiffe," pointing at Eek, who retreated hastily, thinking they drank too much cheap cave brew.

So the game continued. Words by the thousand were invented. Ab became the hero of the colony with his first two-syllable word. He and Ug were systematically naming the animals and they came to leopard. Ab said, "leap," but this somewhat perplexed Ug. Still Ab said, "leap, leap," and finally, "leap hard," and Ug nodded in understanding. For only yesterday he had lost an ear by a "leap hard." The game spread throughout the tribes and each one appointed a head word former, whose business it was to supply names on request. Soon specialists arose. There were word formers for domestic arguments, others for tribal wars, others for lovers, others for business transactions.

From this last branch came a further specialist—the mathematician. At first he merely kept count of things with his

fingers; if he ran short of fingers he called his children to help him, but soon he no longer was able to supply the family hands necessary for the larger transactions, so he started marking in the sand on the floor of the cave. This, too, had its limitations, for even a wealthy mathematician could not afford to keep more than seventeen caves, and when one day the count on oyster shells for Oop & Company filled these, the mathematician finally had to begin inventing names for his numbers. He soon ran out of names, but, luckily, he revised his system by making use of repeated syllables. He also devised symbols to go with the names, and with these a new game was created. Everyone started inventing rules for combining these, and happy indeed was the cave which was able to employ the mathematician who could provide the most elaborate developments, for theirs was the social prestige.

Bridge became a thing of the past. Crossword puzzles went out quicker than did the new fad in women's porcupine trimmed panther skins. Mathematical cave parties were all the rage. Of course a cave man had little to do in those days, except kill an enemy once in a while, or grab a new wife, or hunt a cave if the landlord kicked him out of the old one because he disturbed the people downstairs. Hence the new science developed rapidly and extensively.

ALUMINUM: ITS HISTORY, METALLURGY AND PRODUCTS

A Free Chart for High Schools and Colleges

In order to assist chemistry and industrial arts teachers in high schools, vocational schools, and secondary schools in presenting the chemistry of aluminum to their students, Aluminum Company of America has prepared a display chart on aluminum.

On the front side of the chart, interesting scenes depicting the mining and manufacture of the raw materials used in the production of aluminum serve as a background for actual samples of the various raw materials. The electrolytic cell in which the metal is made is also graphically illustrated, while the history of aluminum and its chemistry are briefly described. On the reverse side of the chart, a diagram traces each step in the production of the metal from the mining of the ore, bauxite, through the fabrication of the primary aluminum products.

The chart is 17 7/8 by 27½ inches in size and is designed to be hung on the classroom wall. It may be secured free of charge by teachers in accredited schools who will write to Aluminum Company of America, 2106 Gulf Building, Pittsburgh, Pa., on the letter heads of their schools.

NATURE INTEREST IN THE BAY OF FUNDY

By K. F. Keirstead
St. Andrews High School, St. Andrews, N. B., Canada

Many features of scientific interest exist in and around the Bay of Fundy. Most textbooks in General Science point out that here are found unusually high tides. An encyclopaedia, probably misinformed, relates that tides of 100 feet have been recorded. However, the greatest tidal difference at Saint John given in the Tide Tables of 1936, is 29 feet for March 25. The latter difference is enough to give surprising effects. It is a common sight to see boats of considerable size left high and dry on the mud at low tide. Passing from the lower part of the Bay to the narrow upper reaches, the tidal difference becomes greater.

At the head of the Bay, thousands of acres of diked marsh land were established by the patient labor of the early Acadians. This is the region made immortal by Longfellow's *Evangeline*. All the rivers of this region, characterized by muddy slimy banks, meander their way to the sea through miles of marshland. At low tide barely a trickle of reddish water may pass down the muddy bed. At high tide the river is filled with sea water. At Moncton, the rapid influx of sea water coming up the river advances as a distinct wall of water, the so-called "Tidal Bore."

At Saint John the advancing tide quickly rises above the level of the water in the Saint John River, and roars through the narrow gorge into the river above, thus giving rise to a falls flowing upstream, the "Reversing Falls." This trespass of the tide into the river gives a noticeable salinity for as far as twenty miles from the mouth. Spring tides cause a rise in the river's level for a much farther distance. At Fredericton, 85 miles from the mouth, a rise of 7 inches takes place at Spring tides.

The Cooper plan to harness the Passmaquoddy tides has been a subject of international interest for several years. After the government of Canada refused to permit an international dam for fear of damaging the fishing industry of the Bay, considerable work was done in preparation for a system of dams on the American side as a relief project.

An interesting light phenomenon was reported by Captain A. Calder while operating the *Zoarces*, a survey vessel of the

Biological Board. His log for July 17, 1936 reports that at 10 P.M. on a still calm sea lights could be seen from all the lighthouses in the Bay of Fundy. The normal limit of visibility in no case is greater than 20 miles, yet lights as far away as 50 miles were seen. Obviously this was a rather unusual occurrence of a mirage.

A NEW TECHNIQUE FOR SOLVING HEAT-EXCHANGE PROBLEMS

By Faith Lee Fitch
Horace Mann School, New York City

A typé of problem which bothers the beginning student in physics is that of heat exchange. I venture to suggest a new form for the solution of these problems. I have found that this form clarifies the thinking of the student and brings about a distinct increase in accuracy. The technique is essentially one of setting up the data in tabular form with a very thorough labelling of the meaning of each item. This can best be illustrated by an example:

100 grams of ice at $-10°$C. are added to 500 grams of water at 80°C. in a copper calorimeter which weighs 100 grams. What is the final temperature of the mixture? Specific heat of copper is 0.095. Specific heat of ice is 0.5.

Substance	Mass	t_1	t_2	Δt	Specific heat or heat of fusion or heat of vaporization.	ΔH	
Ice	100g.	$-10°$C.	0°C.	10°C.	.5	$100\times10\times.5$	Heat gained by ice in warming to 0°C.
Ice	100g.	0°C.	0°C.	0	80	100×80	Heat gained by ice in melting
Ice water	100g.	0°C.	t	$t-0$	1	$100t$	Heat gained by ice water in warming to t°C.

Warm water	500g.	80°C.	t	$80-t$	1	$500(80-t)$	Heat lost by warm water in cooling to t°C.
Calorimeter	100g.	80°C.	t	$80-t$	.095	$100(80-t)\times.095$	Heat lost by calorimeter in cooling to t°C.

$$\text{Heat gained} = \text{Heat lost}$$
$$100\times10\times.5+100\times80+100t=500(80-t)+100(80-t)\times.095$$
$$500+8000+100t=40{,}000-500t+760-9.5t$$
$$609.5t=32{,}260$$
$$t=53\text{°C. approx.}$$

Before the student proceeds from tabulation to setting up of an equation, I feel that it is most important that he make the statement: *Heat gained = heat lost.* This is the principle underlying the problem and it is also the word equation upon which he will then base the construction of his specific equation.

I have borrowed from calculus the symbol Δ to indicate the value of the change in temperature or in heat. I find this symbol less nuisance than the more familiar t_2-t_1 or the reverse, and it has the added advantage that it is unambiguous, since it may be used to represent the absolute value of the change, without regard for sign.

Complete labelling in the first and last columns is a precaution against confusion. The column labelled *specific heat or heat of fusion or heat of vaporization* may be used for whichever of these items is pertinent at the time.

Of course, the unknown quantity may appear in any one of several columns. I used the problem shown here because it presents several difficulties which often cause trouble.

"DRINKS LIKE A FISH"

The old simile, "drinks like a fish," is libelous. Fish don't even drink water. They get plenty of it along with their food, which is always wet and usually contains a high percentage of water.

Fish keep up that constant gulping because they must have a steady stream of water flowing over their gills. There is oxygen dissolved in the water, and the blood in their gills extracts this necessary element, just as our own blood extracts oxygen from the air in our lungs. A fish's "drinking" therefore is rather to be compared with our breathing.

ANNUAL MEETING
EASTERN ASSOCIATION OF PHYSICS TEACHERS

One Hundred and Thirty-Ninth Meeting

NEWBURYPORT HIGH SCHOOL

Newburyport, Mass.

Saturday, May 14, 1938

PROGRAM

9:45 Meeting of the Executive Committee (at the High School).
10:00 Visit to the Towle Silver Shop. (See below.)
11:10 Greetings by Principal Joseph A. Ewart.
11:20 Business Meeting:
Annual Report of the Secretary.
Annual Report of the Treasurer.
Report of the Nominating Committee, and Election of Officers.
11:35 Reports of Committees:
New Books and Magazine Literature.
New Apparatus.
11:55 Demonstration by Mr. Roger C. Chittenden.
12:10 Symposium by new members of the Association:
Mr. Harry A. Johnson, Mr. George W. Seaburg,
Mr. Richard P. Boyer, Mr. John C. Hall.
1:00 Luncheon at the High School
Inspection of the New High School Building.
2:15 Debate: "Resolved that the Elementary Course in Physics Should be Less Mathematical"—
Affirmative: Mr. C. F. Protheroe
Mr. John J. Quinn, Jr.
Negative: Mr. W. Roscoe Fletcher
Mr. Carl Johnson
Discussion.
3:30 Visit to the Caldwell Rum Distillery.

VISIT TO THE TOWLE SILVER SHOP

The Towle Silver Shop in Newburyport represents a business which began there in 1690, at which time William Moulton combined work in silver with the usual work of the blacksmith. During six generations the craft was developed and improved by members of the same family, one of whom was a contemporary and competitor of Paul Revere. The business then passed to two apprentices, Towle and Jones, and finally resulted in the present firm, The Towle Manufacturing Company. The visit to the shop was very instructive and interesting from points of view both of physics and chemistry. The following outline gives a brief summary of some of the processes involved.

Designing Dept.
↓
Designs made up from consensus of

Sterling Silver Sheet from manufacturer (92.5% Silver, 7.5% Copper)
↓

opinion of dealers.
↓
Large model made from design.
↓
Accepted model pantographed to Actual Size. Plastic model made.
↓
Hard steel die made for flat ware (forks, etc.)
→

Weighing Room.
↓
Storage
↓
Machines punch out blanks for flat ware. Spoons rolled by eccentric rollers to give varying thickness.
↓
Shape & design stamped on blanks by steel die and pneumatic drop-hammer.
↓
Trimming Room. Edges trimmed on carborundum belts and wheels.
↓
*Finishing Room
↓

Air in stamping room slightly above atmospheric pressure to keep dust out when doors open. Dust on dies would be pressed into silver.
←

Handles for stainless steel ware.
↓
2 Blanks or halves for each handle.
↓
Design & Shape stamped on each.
2 Halves sputter-welded to hold while working.
Scoop of ground silver solder placed inside each seam.
↓
Shank of steel blade inserted through lead core & placed in handle.
↓
Electric furnace solders & seals handle.
↓
Tested for leakage. To *.

↓
Spun Work (Bowls, etc.)
↓
Flat disc
↓
Spun on lathe & pressed against wood pattern.
↓
Chased Ware
↓
Repoussé design made from inside with snarling iron.
↓
Filled with pitch. (Hardened.)
↓
Design traced on & completed with hand tools.

Burnished (Buffers) | Dull (Fine steel brush) | Antiqued (Dipped in solution of "Liver of Sulphur" K_2S_5)
↓
Polished
↓
Inspected and weighed.
↓
Storage Room.
↓
Wrapping & Shipping.

SILVER RECOVERY

Sweepings from floors.
↓
(A) Furnace burns out dross and melts silver.
↓
Dissolved in acid. Carborundum, tripoli, etc. removed. Silver precipitated by brass scrap. Copper left in solution.
↓
Silver dried and weighed.
↓

Workers' Overalls
↓
Laundry
↓
Wash-water treated for silver recovery.
↓
Filtered
↓
Silver
↓ To A.

Trimming & Finishing. Rooms. Silver mixed with Carborundum, Tripoli, etc.
↓
Dust-flues
↓
Silver dust caught in oil. To A.

Packed in locked barrels.
Sent to sheet silver works
to be made into Sterling
Silver sheet.

Waste metal from
punching blanks.

↓

Weighed

BUSINESS MEETING

The following were elected active members:

V. Russell Beck, Brookline High School, Brookline, Mass.

Frank L. Bridges, North High School, Quincy Mass.

Charles L. Cheetham, Boston Latin School and Lincoln Preparatory School, Boston, Mass.

Harwood Ellis, The Rivers School, Brookline, Mass.

Prof. Dr. W. Franck, Oberrealschule, Hamburg, Germany.

Fred A. Metcalf, Milford High School, Milford, Mass.

The following was elected an associate member:

Charles E. Benton, Needham Senior High School, Needham Heights, Mass.

Mr. Enos E. Held of Concord spoke a few words regarding our new member in Hamburg, Germany, saying that Dr. Franck is Head of The Science Department in the Oberrealschule in that city, is the author of books on Physics, and is one of a committee which is rearranging the courses of study in the North German schools. He said that Dr. Franck is interested in hearing from members of the Association. His home address is Peter Strasse 40, Hamburg-Volksdorf, Germany.

ANNUAL REPORT OF THE SECRETARY

The three regular meetings of the year have been held as follows:

The 137th at Milton Academy, Milton, Mass., December 11, 1937.

The 138th at Harvard University, March 5, 1938.

The 139th at Newburyport High School, Newburyport, Mass., May 14, 1938.

The meetings have been well attended.

On January 22, about fifty members attended a demonstration at the Massachusetts Television Institute in Boston.

A membership drive during the year has resulted in the election of twenty-seven new active members and eight new associate members.

Our membership today is 168, including 131 active, 35 associate, and 2 honorary members.

Respectfully submitted,
CARL W. STAPLES, *Secretary*

Treasurer's Report 1937–1938

May 1, 1938

Balance from previous year				$333.67
Receipts:		Sch. Sci.		
Dues 1936–37 Act.	$ 11.00	2.00		
Assoc.	1.00	1.00		
1937–38 Act.	119.00	235.00		
Assoc.	32.00	32.00		
	$163.00	$270.00	$433.00	
Interest			$ 3.63	$436.63
				$770.30

Expenditures			
Printing & stationery	$40.50		
Postage & clerical expenses			
Secretary	31.70		
Treasurer	26.00		
Stenographer	11.30		
Salary of secretary	50.00		
Expenses of meetings	3.50		
Dues. Am. Sci. Tea. Assoc.	5.00	$168.00	
School Science		$273.00	$441.00
Balance Forward			$329.30

ASSETS

Arlington National Bank (checking acct.)	$205.02	
Charlestown Five Cents Savings Bank	124.28	
Cash	000.00	
		$329.30

PRESTON W. SMITH, *Treasurer*

Mr. Smith proposed a change in the time of sending out bills for dues, suggesting that they be sent out in June instead of in October as heretofore. The reason for the change is that it would enable members of the Association to receive their copies of SCHOOL SCIENCE AND MATHEMATICS earlier in the fall. This was approved by those present.

The Nominating Committee, Mr. Fred R. Miller and Mr. Burton L. Cushing, presented the following candidates who were then elected to serve for the ensuing year:

President: Ralph H. Houser, Roxbury Latin School.

Vice-President: John P. Brennan, Somerville High School.

Secretary: Carl W. Staples, Chelsea High School.

Treasurer: Preston W. Smith, 208 Harvard St., Dorchester, Mass.

Executive Committee: Lawrence A. Howard, East Boston High School; John C. Gray, Phillips Andover Academy; and Charles S. Lewis, Brighton High School.

Principal Joseph A. Ewart of the Newburyport High School welcomed the Association most cordially. He then spoke briefly about the new building. It is in the Colonial style with about thirteen acres of land. A graded terrace in back forms a football field, and a lower terrace is a baseball field. There are to be four tennis courts, and bleachers for 5000 spectators.

By removing partitions, and building on, the two wings can, if necessary, be extended or even joined together. The school has an enrollment of 875 pupils, 125 of whom come from several surrounding communities. It is on the highest point and geographical center of Newburyport, cost $470,000 exclusive of land, with $31,000 equipment.

It was voted that the Eastern Association of Physics Teachers express to Principal Ewart and to Mr. Chittendon a vote of thanks for their hospitality, and also to the chef of the school for the excellent luncheon he prepared.

REPORT OF COMMITTEE ON MAGAZINE LITERATURE AND NEW BOOKS

MR. CHARLES B. HARRINGTON, *Chairman, Newton High School*

PROFESSOR CHARLES W. BANKS, *Wentworth Institute*
MR. THOMAS C. BAILEY, *Hartford Public High School*

MAGAZINE LITERATURE

Science News Letter

"No Two Alike" (snow flakes)	Dec. 18, 1937
"Physics Discoveries in 1937"	Dec. 25, 1937
"Engineering and Technological Advances in 1937"	Dec. 25, 1937
"New Gas Discovered in High Atmosphere"	Jan. 8, 1938
"Diesel Engines for Airplanes"	Jan. 22, 1938
"Microscopic Magnification to 50,000 Diameters"	Jan. 22, 1938
"Cellulose Film on Windows for Winter Protection"	Jan. 29, 1938
"Exploring Ocean Depths"	Feb. 12, 1938
"New Electron Furnace-Heats to 4500° F."	Feb. 12, 1938
"New Physical Theories Enter Practical Field"	Mar. 5, 1938
"Pictures Through a Pipe (coaxial cable in television)"	Mar. 12, 1938
"Polarvid—(Patent tangle clears) May Now be Used for Non-glare Lights"	Apr. 2, 1938

Bell Laboratories Record

"New Cathode Ray Tube"	Dec. 1937
"Forecasting Sun Spots and Radio Transmission Conditions"	Dec. 1937

Focus—Published by Bausch & Lomb

"Splitting Hairs" (Microscopy)	Jan. 1938

Science

"Studies in Acoustics"	Dec. 3, 1937
"Modern Physics for the Layman"	Dec. 17, 1937
"Radio Waves in Treatment of Disease"	Dec. 17, 1937
"Outstanding Events of Science in 1937"	Dec. 24, 1937
"Possible Origin of the X ray Particle"	Dec. 31, 1937
"Outstanding Events in Engineering and Technology for 1937"	Dec. 31, 1937
"The Mass of the X Particle"	Jan. 14, 1938
"Long Distance telephonic Communication"	Jan. 28, 1938
"Baby Atom Smasher"	Jan. 28, 1938
"Radiation,—Cross Between Heat & Radio Waves"	Feb. 4, 1938
"New High Temperature Furnace"	Feb. 11, 1938
"A New Type Cyclotron"	Feb. 18, 1938
"Doubts Concerning the Neutrino Particle"	Feb. 18, 1938
"Home Facsimile Receivers"	Feb. 18, 1938
"Cosmic Rays"	Mar. 4, 1938
"The Magnetism of the Earth"	Mar. 11, 1938
"A New Blind Landing System"	Mar. 18, 1938
"A New Vacuum Tube for Television"	Apr. 15, 1938
"A New Lens—(Metrogon) for Aerial Photography"	Apr. 15, 1938

Science Digest

"What the X-ray Has Done for Man	Jan. 1938

"Putting Rare Gases to Work"	Jan. 1938
"The Mechanics of Sport"	Jan. 1938
"The Advance of Stainless Steel"	Jan. 1938
"Social Effects of Inventions"	Jan. 1938
"Why Not the Metric System?"	Jan. 1938
"Developing the Airplane Propeller"	Jan. 1938
"News Pictures by Wire"	Feb. 1938
"Strange Effects of Extreme Cold"	Feb. 1938
"Edison—Scientist & Inventor"	Feb. 1938
"Our Spinning Earth"	Mar. 1938
"The End of the World"	Mar. 1938
"Tomorrow's Telephones"	Mar. 1938
"Review of Science in 1937"	Mar. 1938
"Progress of Television"	Mar. 1938
"Greater Depths for the Diver"	Apr. 1938
"The Ozone Layer Above the Clouds"	Apr. 1938
"Measuring to 5-Millionths of an Inch"	Apr. 1938
"The Newly Discovered Elements"	May 1938
"New Era in Heating and Air Conditioning"	May 1938
"The Flow of Electricity"	May 1938
"Million Volt X-Rays"	May 1938

Popular Science Monthly

"Steam Still Rules the Rails"	Dec. 1938
"Amateur Scientist Uses Home Made Instruments"	Jan. 1938
"One Piece Railroads (welding)"	Feb. 1938
"Television Gets a Trial"	Apr. 1938
"How We Speak (Sound)"	Apr. 1938
"Ceiling Zero (radio)"	May 1938
"Ten Miles a Minute—Straight-Down"	June 1938

Scientific American

"As the Camera Sees It"	Dec. 1938
"Railroads by the Mile"	Dec. 1938
"The New Heavy Nitrogen"	Dec. 1938
"Telescopes"	Jan. 1938
"Record Speed Films"	Jan. 1938
"Science of Alloy Building"	Feb. 1938
"New Astronomical Advances"	Mar. 1938
"China and Modern Science"	Mar. 1938
"Camera Engraving"	Mar. 1938
"Cathode Ray Tube Development"	Mar. 1938
"Industry Needs More Light"	Apr. 1938
"The Diesel Broadens its Field"	Apr. 1938
"Grits for Grinding"	May 1938
"Number One Rocket Man"	May 1938
"Unpuzzling Color"	May 1938

Popular Mechanics

"Modern Magic of the Light-Benders" (optics)	Dec. 1938
"Television in Germany"	Jan. 1938
"The Boy that Grew Up" (gyroscope)	Feb. 1938
"The Flying Wing of the Future"	Feb. 1938

"Physical Instruments and Crime Detection"	Mar. 1938
"Splitting Hairs . . . " (Precision Measurement)	Mar. 1938
"The Biggest Thing on Earth"	Apr. 1938
"Putting the Atom to Work" (cyclotron)	May 1938
"The Advance of the Diesel"	June 1938
"Wind Changes" (Electrical)	June 1938

NEW BOOKS

1. *Atomic Artillery*, by J. K. Robertson. Van Nostrand. Non-Mathematical study of the invasion of the atom.
2. *History of Science and the New Humanism*, by G. Sarton. Published by Harvard University. A stimulating view of the history of Science.
3. *The Teaching of Physical Sciences in the Secondary Schools of the U. S., France, and Soviet-Russia*, by Alex. Efron. Published by Teachers College, Columbia. International comparison of methods and materials.
4. *Photographic Hints and Gadgets*, by Frafrie & Jordan. Amer. Photographic Pub. Co. Of value to both amateur and professional photographers.
5. *Glossary of Physics*, by Prof. Le Roy D. Weld. Published by McGraw-Hill. Hundreds of terms and items in condensed form.
6. *Low Temperature Physics*, by Ruhermann. Macmillan. Bibliography. Covers work on low temp. to present time.

President Houser recommended *From Galileo to Cosmic Rays* by Professor Harvey Brace Lemon of the University of Chicago, and published by the University of Chicago Press. He called it Physics with a smile, authoritative, up-to-date, dramatically written, and interestingly and informally illustrated, some of the illustrations being stereoscopic.

He asked members to bring in reports of any new books.

Mr. Fred R. Miller mentioned *These Amazing Electrons*, by Raymond Yates, Macmillan Co., publishers, $3.75 and also *Inside the Atom*, by Langdon-Davies, $2.00. Harper, publishers.

REPORT OF NEW APPARATUS COMMITTEE

Three Demonstration Experiments

DR. ANDREW LONGACRE

Members of the Eastern Association of Physics Teachers and Guests. Two of the three demonstrations which I want to show you deal with situations found in Mechanics. They arose from reflections regarding machines and the place that the study of machines should occupy in a one year Physics course. You probably find that section just about as hard to teach and as boring as any portion. It is loaded with problems that the boys don't or will not see through. Compared to the work that comes later it is static and dead. Are simple machines introduced because they furnish nice illustrations of the laws of moments and resolution of forces? If so, then it seems a waste of time for those are not used again even though magnetism and electricity afford suitable opportunities. Are they in the course because the boys are already familiar with them and interested in them? Certainly the boys of today are not nearly as familiar with simple machines as the boys of a generation ago. For one reason or another simple

machines have, to a large extent, left our everyday life. And as to interest, at the age when most boys take physics, their interest has gone from mechanical devices to electrical devices.

However, the case for the intensive study of the machine is not lost. Unlike electrical devices, there is no mystery as to their operation. With a glance, most boys can tell how they will perform. Thus, in this field, at least, the attention can be focussed on the physical principles at stake. Wasn't it from machines that man first developed the concepts of work and energy? And today, are they not still the best means with which to develop those concepts, rigorously, logically and comprehensively, so that they become an integral part of the boy's mental processes?

Most definitions of machines center around the idea of "changing a force for practical reasons." Is not that purely incidental to the fact that *machines are devices to aid man in accomplishing some task he wishes to accomplish?* Is not this the very "raison d'être" for the machine? In fact I believe it is the only valid definition. Necessity is the mother of invention and from the loins of necessity arose machines. A pair of tweezers is used to place a small screw in a watch because man's fingers are too clumsy. The task is clear, the desire is clear, and the need for the tweezers is clear. Any change of force is of secondary consideration. However, in most cases machines are used because the ability of ordinary man to exert a force is limited. There are many tasks that simply require more force than man, in himself, has at his disposal. Hence the machine and it is just this that the apparatus is designed to show.

The apparatus consists of a plank on supports which acts as an elevated road-bed for a toy tractor (Fig. 1). Man and his effort are represented by the tractor. The toy tractor has been weighted with lead to increase its traction. The task to be accomplished is the lifting of a brass roller from

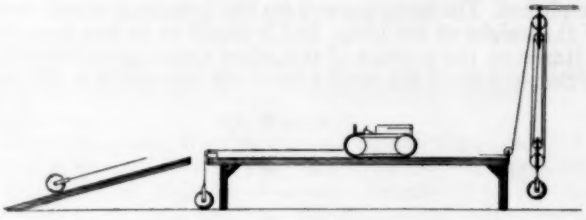


FIG. 1

the table up to the level of the road. Yes! a task requires the exertion of a force through a distance. Work is the technical name that is given to that which is required for the accomplishment of a task. A rope is connected to the tractor and to the hook on the yoke of the roller and passes over the pulley at the end of the road-bed. The tractor is started and it pulls the roller until it gets directly under the roller. Then it stops. It cannot lift the roller directly. It just cannot exert that much force. However can it accomplish the task? Can it do the work?

Now assist it with a double block, double sheave, pulley system which is hung from a clamp and stand. For once the small pulleys obtained from the supply house are being used for a real job, and the tractor does lift the roller to the height of the road-bed. The task has not been reduced. The desired amount of work is done. However, the tractor has been pulling through a greater distance than if it had lifted the roller directly. The force has been reduced but the actual reduction of the force has been more

than made up in the extra distance moved. *The work done by a machine is, at best, equal to that done by the operator.*

Now let us place an incline at one end of the road-bed and connect the roller to the tractor. Again it succeeds in getting the roller up to the level of the road-bed.

The next demonstration is with the lever. However, again I feel the lever should be used to accomplish a task. The lever has one end on a sturdy support and the other end on a spring scale whose dial is purposely turned away from you (Fig. 2). A heavy weight is hung from the lever about one quarter of its length from the support. A spring balance is now

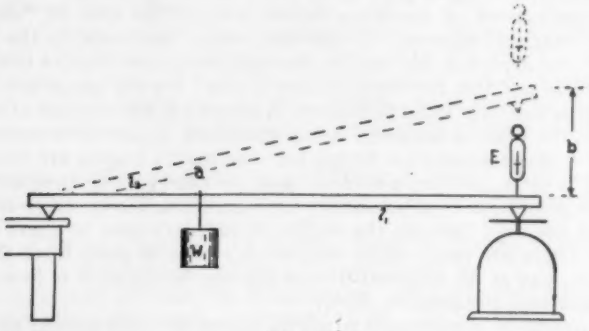


FIG. 2

hooked to the end of the lever on the balance. Now by lifting this balance the weight is lifted through a short distance. This is the task that was to be accomplished. The force exerted by the balance is noted corrected for one-half the weight of the lever, and is found to be less than that of the weight. However, the product of this effort times the distance it moves is equal to the product of the weight times the distance it is moved. Thus

$$E \times b = W \times a$$

or

$$\frac{W}{E} = \frac{b}{a}$$

however

$$b : a :: l_1 : l_2$$

therefore

$$\frac{W}{E} = \frac{l_1}{l_2} \text{ or } Wl_2 = El_1$$

which is the law of moments.

My electrical demonstration is a frill that it seems worth while to add to usual demonstration of electromagnetic induction. One of two large coils of wire is connected to a table galvanometer (Fig. 3). The other is connected in series with a rheostat and a switch to some dry cells. A bundle of iron wires serves as the magnetic bridge between the two coils. Naturally the galvanometer shows a current with either the closing or the opening of the switch. Now close the switch and leave it closed. After the first throw of the galvanometer it comes to rest at zero, as expected, even though a current is still running in the primary. However, changing the current in the primary by adjusting the rheostat immediately produces a

current in the secondary. That current flows along as the current in the primary is changing and is proportional to the rate of change. Further it is in the direction for an increasing current is opposite to that for a decreasing current. We have found the induction of a current in the sec-

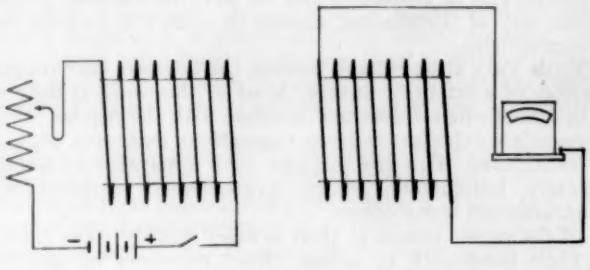


FIG. 3

ondary by small changes in the primary even more interesting than that induced by the make and break and that is my excuse for calling your attention to it.

In closing I want to thank you for your patient attention and to express the hope that these demonstrations may be of some assistance to you and your work.

APPARATUS DEMONSTRATED BY ROGER C. CHITTENDEN

Heat engine—old.

In a double cylinder, the expansion of air on being heated and then cooled in the by-passes, produces the unbalanced pressure.

Electric engine—old.

Two electro-magnets, their armatures in one frame, hinged in the middle so as to rock. The rocking motion runs a walking beam which turns the fly wheel, the axle of which is insultated on one side. The two brushes alternate in touching the uninsulated half of the axle and carry the current first to one electro-magnet and then to the other.

Telegraph receiver—old.

The electro-magnet works a long armed lever with a sharp point on the long end, which digs into a paper tape which is drawn over it.

Working model of a steam engine, said to have been built by a former pupil.

A diamond shaped frame with divided circuit, each side carrying a 60 watt lamp of clear glass and the "bridge" a 25 watt lamp. Of help in explaining the balancing of a Wheatstone bridge. Taken from a description in SCHOOL SCIENCE AND MATHEMATICS of a couple of years ago.

Automatic gas lighters. A panel with wall push buttons to light and put out a gas jet on the next floor. Also one with a chain pull for wall light. Shows action of a choke coil.

Set of clips for quick connecting of cells in parallel.

Barograph cards showing change of atmospheric pressure on trips by auto from Newburyport (nearly at sea level) to Franconia Notch.

Log cut at a mill to show plane and quarter sawing (Gen. Science).

SYMPOSIUM BY NEW MEMBERS OF THE ASSOCIATION

A. Stimulating Interest with Science Projects

MR. GEORGE W. SEABURG, *Hyde Park High School*

If an interest can be created in any subject, the learning process is improved. One way of stimulating interest in science is to have the pupils make science articles.

In the Hyde Park High School, Boston, the boys are encouraged to construct devices of a scientific nature. Most of this work is done either at home or in school when it does not interfere with the regular school work. The various science classes are given suggestions regarding projects which may be constructed. This list includes such apparatus as electric bells, galvanometers, barometers, pumps, hygrometers, temperature alarms, electric furnaces and many others.

Many of the pupils complete their articles quickly; they take pride in bringing their handiwork to school. Other members become interested when they see these projects and competition begins to see who can construct the best device. All pupils in the school see the collection of projects which is exhibited in a large cabinet in the foyer. Students in other courses enjoy seeing the exhibition; many pupils are influenced to include science in their programs in their following year.

The construction of these articles has other values besides stimulating interest. First, it keeps the youths out of mischief by giving them something to do. Second, it may provide a hobby for their later years. Third, they study books and diagrams; this increases their knowledge and ability to follow directions. As the majority of my boys in science are interested in shop work, or work of a mechanical nature, they enjoy making things with their hands. These boys realize the value of science in a practical way.

Here are a few of the science projects submitted by the boys this year. This hydraulic press was designed and constructed by a senior who works in an outside machine shop every other week; it was made in this shop after working hours from scrap material. The educational value of these science articles is shown by this Bunsen burner. When the boy brought it to school, it had a very large gas orifice and very small air holes. After bushing the gas opening and drilling larger air holes, the burner functioned properly. You may be sure that this young man realizes better than ever the necessity of sufficient air for proper combustion. These pumps were made by two juniors as extra work in the school shop. You will notice that no provision has been made for priming. To prevent such errors in the future, boys will be requested to submit drawings of their projects before proceeding with the construction. Here is a steam engine built by a sophomore boy. It was built from plans purchased from a Boston newspaper.

You are cordially invited to examine these projects which include a jack. plumb-bob, galvanometer, question and answer set, a sample of etching, a pin hole camera, and an apparatus for demonstrating center of gravity.

I believe that these projects not only help to stimulate interest in science but are also a valuable teaching aid.

B. The Sine Curve of Voltage of a Generator

MR. RICHARD BOYER, *Newton High School*

Many pupils see in a textbook a diagram of a sine curve of voltage and pass it by. With that they lose a chance of a better comprehension of generation of electricity and what is meant by phase.

Using a rubber suction cup as a center and a 16 inch piece of annunciator wire as a diameter, locate on the blackboard the north and south poles of a bipolar generator, and indicate a number of lines of magnetic flux with arrows directed toward the right. On each end of the annunciator wire is threaded a large, bright button, and held in place by bending tightly the end of the wire. These buttons against the magnetic field represent a cross-section of a single loop of a conductor. By slowly rotating the diameter wire the buttons will be seen to cut the lines of force. Fleming's rule of three fingers—the "six-shooter" rule—indicates that the button on the right, rotating clockwise, is a conductor leading generated current toward you.

To study the magnitude of the current voltage, make a stop-motion diagram of the rotation of the buttons with a stop every ten degrees. Draw the upper right quadrant of a circle using a 24 inch radius and divide this into nine arcs ten degrees each. Now from these points of division draw vertical and horizontal lines to intersect the inside of the circle. The result looks like an irregular flight of steps. If the verticals are colored with orange chalk, they will stand out as a measure of the relative number of lines of flux cut in equal periods of time as the coil rotates uniformly. Only one quadrant need be filled in as the others will repeat the first symmetrically.

As the voltage varies as the number of lines of flux cut in an interval of time, the orange vertical measures may be plotted against time. The result of this plotting will be a sine curve of voltage. (The relative measures will be as follows: 1.5; 4.5; 7.5; 10; 12.5; 14.5; 16; 17; 17.5.)

This may be demonstrated experimentally by modifying a $\frac{1}{4}$ horsepower A.C. motor as a generator. The armature is connected to slip rings and wired to a d'Arsenval galvanometer. The field is excited by 110 volts direct current. One end of a double extension shaft has a grooved pulley on which to hang a $\frac{1}{2}$ kilogram weight as motive power. Stop motion control is obtained by a 36 tooth gear with a trigger catch, located on the opposite side of the shaft from the pulley. The 36 teeth allow voltage observations every ten degrees.

C. An Apparatus for Demonstrating the Principle of Television

MR. HARRY A. JOHNSON, *North Brookfield High School*

Mr. Johnson described a scanning disc made by cutting a cardboard circle twelve inches in diameter. This was divided by radii into 32 equal segments. Placing a spool one inch in diameter at the center of the card, and attaching to the spool a thread having a pencil at the other end, a spiral was drawn by allowing the thread to wind up on the spool. At each point where the spiral intersected one of the 32 lines, a hole $\frac{1}{4}$ inch in diameter was made.

The card was then placed on an ordinary rotator, a light source was paced back of it, and a ground glass screen in front. A picture of the light blulb or the letters on the bulb was obtained on rotating the disc rapidly.

D. Problems in Non-College Physics

MR. E. VICTOR KNAPMAN, *Newton High School*

Mr. Knapman described methods of treating problems in non-college Physics. The course mentioned was a terminal course in Science, a senior elementary Physics course, where pupils, hearing rumors that Physics is difficult had a poor attitude toward the subject.

He used a heat unit problem as an illustration of the method of treating the subject.

This was to calculate the definite number of B.T.U. required to heat a house through a season of 5000 hours. This involved.

Supply of air per hour.

B.T.U. to heat this amount of air.

Loss of heat through walls.

Loss of heat through windows and doors.

This was based on hot water or steam.

Next the cost of heating was considered per week, month, and season, using different fuels as gas, oil, coke, and coal.

All problems were linked with outside situations, stressing the economic side.

In light, the correct way of lighting stores to bring out color effects could be studied. Pupils taking this course had it four times a week for 1 hour. They had science three years: 1st, General Science; 2nd, Chemistry; 3rd, Elementary Physics.

RESOLVED THAT THE ELEMENTARY COURSE IN PHYSICS SHOULD BE LESS MATHEMATICAL

Affirmative arguments by CHESTER F. PROTHEROE

1. I assume as a guiding principle in this discussion that we are inferring that the requirements of the C.E.E.B. have no bearing upon what the physics course should be. Otherwise, there could be no debate, as the present mathematical content is necessary in preparing pupils for the examinations as now set.
2. What are the objectives of the pupils whom we teach?

   A substantial majority of high school students do not enter college, but end their formal education upon graduation from the senior high school. More of these non-college pupils might enjoy a physics course and feel equal to dealing with it if it were not reputedly so laden with mathematics. Comparatively few high school students really enjoy mathematics as generally taught.
3. Does elementary physics as now taught prepare pupils for greater success in college physics?

   A report published this spring by the Committee on Tests of the American Association of Physics Teachers shows a median difference of only 5 percentile points between those students entering college with previous study of physics and those entering without previous study in this subject. True, the tests at the end of the year show a difference of 22 percentile points between the two groups, but this leaves as a moot point the question whether the mathematical or the informational background had greater influence on college success. It is interesting to note that quoted samples of test questions having highest validity were in general of a purely informational or slightly mathematical type.
4. Aside from college entrance, what are the objectives to be attained by a course in physics?

   A. An understanding of the physical environment and how it operates.

   B. A training in the scientific method of thinking.

   C. Experience in manipulation of laboratory apparatus.

   D. The appreciation of and confidence in the orderliness of natural phenomena, in a chaotic social world.
5. Can these objectives be attained with the use of less mathematics than is now prevalent?

   Emphasis can certainly be laid upon the qualitative aspects of physics in explaining the operation of the physical environment. "How

does it act?" is more important to the average student than "How far and how much?" Demonstrations of the mathematical accuracy of the various physical laws can be made by the instructor, with adequate appreciation by the students of their definiteness.

Great opportunity for correlation with other fields of instruction is available to the physics instructor in developing the scientific method of thinking. This term is unfortunate, because the notion that it has to do only with science has caused it to go largely unrecognized in such areas as the social studies. Certainly there *need* be nothing mathematical about logical reasoning.

Laboratory manipulative experiences generally involve the necessary inclusion of some mathematics, but the emphasis should be placed upon manual accuracy in experimental procedure.

Finally, the appreciative and esthetic values latent in the idea of an orderly physical world have small need of mathematical buttressing. In a social world where man, through selfishness or ignorance, repeatedy violates economic law and brings upon his fellowman consequences over which he has no control and which imperil his means of subsistence and his very life, the realization that physical laws are stable and inviolable is a real and abiding comfort to the student.

A FEW REASONS FOR NOT RESTRICTING MATHEMATICAL PHYSICS

MR. CARL JOHNSON

I. *For the Subject of Physics*

1. Satisfies the scientific requirements for:

directness	conciseness	logic
definiteness	completeness	universality

2. It is the SIZE language. As such it is an invaluable aid in mensuration, experimentation, generalization
3. Offers to Physics a variety of expression:

vectors	models	measuring devices
graphs	various branches of math.	calculating devices

4. The multiplicity of units in Physics admits of no other treatment
5. Supplies a needed correlation between the various branches
6. Funishes an additional sense, as it were, through which the intellect may consider phenomena not encompassed by our senses

II. *For the Teacher*

1. It is valuable in imparting idea. Example $-F::mv/r$
2. Time saver. Consider difficulties in demonstrating above exp.
3. Provides simple and effective means for testing to what extent idea has germinated
4. It forms the connecting link to extending idea to other applications
5. Acts as a class stabilizer—if taken in regular doses
6. Helpful in experimental analyses
7. Satisfies, when arising from motivated problems, the other requirements of a good assignment:

directed thinking	progressive difficulty
definite	suggests previous associations

III. *For the Pupil*

1. It lays the foundation for future growth
2. It is valuable training, if for no other reason than that it requires systematic, orderly, accurate presentation, forces concentration and careful analysis, cultivates precision in statement, measurements, conclusion
3. In testing results and conclusions
4. Through its generalizations it:
   aids understanding—is a guide to learning—and
   prescribes methods of doing
5. If, as studies of Burt and Schorling on the "Slow Child" seem to show, he lacks system, concentration, is slow in generalizing, aimless, why isn't math. the proper antidote?
6. Assists in evaluating reasonableness and accuracy of work
7. Helps, through graphs and models, to establish meaning of trends, relationships between variables, relative values, limitations.

IV. *Problem analysis of text books used in Worcester*

Book *A* has	364	quantitative	In *A*	280—78%	solved by proportion
B	447	problems	65	18	power equations
C	574		5	1	quadratics with x term
Each has about 40 generalizations			14	3	require geometry

ONE generalization a week
Is an average of ONE problem in class a day EXCESSIVE???
ONE problem at home a day

V. *Graph* of results of last ten weeks' work on heat in:

	Problems	Recitations	Experiments	Exams	Gen'l Av.
Medians	71	72	74	73	72

Note: uniformity; upward swing for slow pupils is not alone in prob. IS the mathematical side of Physics UNDULY difficult?

VI. The popular challenge to mathematics is acknowledged. We contend it should be met with *BETTER, not LESS, mathematics.* To illustrate, we have a few suggestions in dealing with the following:

Proportion	Mechanics
Unit correlation	Graphs and Models
Simplified Analyses	Symbols used
temperature	Gas Laws
acceleration prob.	Consolidation of rules
parallel circuits	Better definitions
vibrating strings	

VII. *A MATH REVIEW COURSE* for the first two weeks, and running concurrently one afternoon a week thereafter, has been decidedly helpful. In this course the following have been stressed:

Proportion	Significant numbers
Power Functions & Graphs	% variation
Square root	Slide rule computations

VIII. Mathematics sometimes *simplifies experiments, and gives added significance to them.*

Illustrated by experiment on center of gravity

IX. *Results justify the means*

Endorsed by our chemistry associates

Attested to by the records of our graduates. Mid-year reports indicate honors received by 13 out of 15 at W.P.I.; 2 out of 2 at M.I.T.; 1 out of 1 at Oberlin; 1 out of 1 at Colgate.

Confirmed by advanced classes in our own school. In my present Physics IV class (20 weeks course, 1 period daily) we covered half of *Jamesons Mechanics*, including 200 prob., and we shall probably cover half of Timbie—*Elements of Electricity*. It is really fun to teach these classes.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1544. *H. R. Mutch, Eric Tuer, Daniel Finkel.*

1545. *David Gordon.*

1546. *Eric Tuer.*

1547. *David Gordon.*

1548. *S. Ahmad Husain, Luchnow, India.*

1549. *H. R. Mutch, Eric Tuer, David Gordon, New York. Daniel Finkel, S. Ahmad Husain, Luchnow, India.*

1550.

Find a formula for the number which is divisible by 7, such that when the number is divided by each of the integers 2, 3, 4, 5, 6, a remainder of one results.

Solution by H. R. Mutch

Let n = the number

Then $n=60x+1$, since L.C.M. of 2, 3, 4, 5, 6, is 60. (1)

Since the number is divisible by 7, we set

$$\frac{60x+1}{7}=k, \text{ where } k \text{ is an integer.} \tag{2}$$

Multiplying by 2, $$\frac{120x+2}{7}=17x+\frac{x+2}{7}=2k \tag{3}$$

whence $\frac{x+2}{7}$ is also an integer, say m.

Then $\frac{x+2}{7}=m$ and $x=7m-2$, substituting in (1)

$$n=60(7m-2)+1.$$

$$n=420m-119, \ m \text{ any integer.}$$

Other solutions giving this answer or $420m+301$ were given by Norman Greesspan, M. Freed, Wilmington, Calif., Aaron Buchman, Buffalo, N. Y., D. F. Wallace, Charles W. Trigg, Los Angeles, M. Kirk, West Chester, Pa., and C. R. Cassity, Chicago.

1551. *Proposed by Raymond Beck, Wilmington, Calif.*

How many different triangles are there whose sides are integers less than 100?

Solution by Aaron Buchman, Buffalo, N. Y.

Let the sides of the required triangles be integers a, b, c, such that

$$a \geqq b \geqq c. \tag{1}$$

Let side a have the fixed value k. We may tabulate the triangles as follows, keeping in mind relation (1) and the relation $a<b+c$.

side a	side b	side c has the range	No. of Possible triangles
k	k	1 to k	k
k	$k-1$	2 to $k-1$	$k-2$
k	$k-2$	3 to $k-2$	$k-4$
⋮	⋮	⋮	⋮

Thus the total number of triangles possible, when $a=k$, a constant, is

$$S_k=k+(k-2)+(k-4)+\cdots \text{ to zero.} \tag{2}$$

When k is *odd*, the sum (2) becomes

$$S_k=1+3+5+\cdots+k=\frac{k^2+2k+1}{4}. \tag{3}$$

When k is *even*, the sum becomes

$$S_k=2+4+6+\cdots+k=\frac{k^2+2k}{4}. \tag{4}$$

Since each of the sides of the required triangles must be less than 100, k varies from 1 to 99, and we get the following grand total by using (3) and (4)

$$T=\tfrac{1}{4}[(99^2+2\cdot 99+1)+(98^2+2\cdot 98)+(97^2+2\cdot 97+1)+\cdots$$
$$+(2^2+2\cdot 2)+(1^2+2\cdot 1+1)$$

or $$T=\tfrac{1}{4}[(99^2+98^2+\cdots+1^2)+2(99+98+\cdots+1)+50]].$$

Using the formula for the sum of the squares,

$$S_{x^2}=\frac{x(x+1)(2x+1)}{6}$$

and the formula for the sum of an arithmetic series, we get

$$T=\tfrac{1}{4}\left[\frac{99(100)(199)}{6}+2\cdot\frac{99}{2}(100)+50\right]$$
$$t=\tfrac{1}{4}[328350+9900+50]$$
$$t=84{,}575 \text{ possible triangles.}$$

Solutions were also offered by Norman Greenspan, Brooklyn, A. L. Epstein, Bronx, N. Y., D. F. Wallace, W. R. Smith, Chicago, Thomas A. Pickett, South Weymouth, Mass., Hugo Brandt, Chicago, Daniel Finkel, New York and Charles W. Trigg, Los Angeles City College.

1552. *Proposed by Willis Waggoner, Syracuse, N. Y.*

Eliminate θ from the equations:

$$a\cos\theta-b\sin\theta=C$$
$$2ab\cos 2\theta+(a^2-b^2)\sin 2\theta=2C^2.$$

Solution by M. W. Keller, Purdue University

Substituting in the second equation for $\cos 2\theta$ and $\sin 2\theta$ in terms of functions of θ gives, when factored

$$(b\cos\theta+a\sin\theta)(a\cos\theta-b\sin\theta)=C^2.$$

Since the second factor is equal to C we have

$$b\cos\theta+a\sin\theta=C.$$

If we square this equation and add to it the square of $a\cos\theta-b\sin\theta=C$ we get the desired relation

$$a^2+b^2=2C^2.$$

Solutions were also offered by Arthur Danzl, S. E. Field, Ironwood, Mich., W. R. Warne, D. L. MacKay, New York, H. E. Ellingson, Decorah, Iowa, M. Kirk, T. J. Shouse, Liberty, Mo., C. R. Cassity, Chicago and Charles W. Trigg.

1553. *Proposed by Dewey C. Duncan.*

Discuss common factors of integers x, y, and z, which satisfy the equation:

$$3x^2+4y^2=5z^2.$$

Solve this equation completely.

Solution by Dewey C. Duncan

The only integral solutions are (0, 0, 0). Let $4y^2=t^2$; rewrite as $5z^2-3x^2=t^2$. Let x, z, t have no common factor other than 1. Note that $5z$ ends in 0 or 5; and that $3x$ ends in 0, 3, 2, 7, 8, or 5. Therefore t^2 must end in 0, 5, 2, 3, 7, or 8. Since no square can end in 2, 3, 7, or 8, t^2 must end in

5 or 0. Therefore $t=5k$. Reference to the equation $5z^2-3x^2=t^2$ shows that x must contain factor 5; i.e., $x=5h$, whence the equation yields $5z^2-3(5h)^2=(5k)^2$. Accordingly z must also contain the factor 5; Hence x, y, z, contain the common factor 5 contrary to the assumption that they have no common factor besides unity.

A solution was also offered by H. P. Mutch.

1554. *Proposed by Walter R. Warne.*

Eliminate θ and ϕ from the system of equations:

$$a\cos^2\theta+b\sin^2\theta=c$$

$$b\cos^2\phi+a\sin^2\phi=d$$

$$a\tan\theta=b\tan\phi.$$

Solution by D. L. MacKay, New York

$$a\cos^2\theta+b\sin^2\theta=c \tag{1}$$

$$b\cos^2\phi+a\sin^2\phi=d \tag{2}$$

$$a\tan\theta=b\tan\phi. \tag{3}$$

From (1)

$$a\cos^2\theta+b\sin^2\theta=c(\cos^2\theta+\sin^2\theta).$$

Hence:

$$\tan^2\theta=\frac{a-c}{c-b}. \tag{4}$$

In like manner from (2)

$$\tan^2\phi=\frac{b-d}{d-a}. \tag{5}$$

From (3)

$$a^2\tan^2\theta=b^2\tan^2\phi \tag{6}$$

Substituting (4) and (5) in (6),

$$a^2(a-c)(a-d)=b^2(b-c)(b-d).$$

Solutions were also offered by J. Byers King, Corsica, Pa., Charles W. Trigg, Los Angeles, M. Freed, Wilmington, Calif., M. W. Keller, Purdue University, Aaron Buchman, Buffalo, Norman Greenspan, Brooklyn, N. Y., Ethel Cain, Perry, Iowa, Eric Tuer, Toronto, Canada, S. E. Field, Ironwood, Mich., Margaret Joseph, Milwaukee, Wis., H. Brandt, C. R. Cassity and the proposer.

1555. *Proposed by Walter R. Warne.*

In the folium of Descartes (see 1534) can the area of the loop be found by any branch of mathematics other than the integral calculus?

Also find or discuss the area formed by the asymptote of the folium and the portion of the folium exclusive of the loop.

Solution by Arthur Danzl, Collegeville, Minn.

By rotating the axes through 45°, the equations of the curve and the asymptote are respectively:

$$y=\pm x\sqrt{\frac{3-\sqrt{2}x}{3\sqrt{2}x+3}} \quad \text{and} \quad x=-\frac{\sqrt{2}}{2}.$$

The area between the asymptote and the two branches of the curve is given by

$$A=\lim_{\epsilon\to 0} 2\int_{-\sqrt{2}/2+\epsilon}^{0} x\sqrt{\frac{3-\sqrt{2}\,x}{3\sqrt{2}\,x+3}}\,dx; \qquad \text{Let } \frac{3-\sqrt{2}\,x}{4}=\sin^2 z \quad \text{and}$$

we obtain

$$A=\lim_{\delta\to 0}\frac{8}{\sqrt{3}}\int_{\pi/3}^{\pi/3-\delta}(4\cos^2 z-1)\sin^2 z\,dz=\lim_{\delta\to 0}\left[\frac{8\sin^3 z\cos z}{\sqrt{3}}\right]_{\pi/3-\delta}^{\pi/3}=\frac{3}{2}\sqrt{3}.$$

The area is a limiting value, since at $x=-\sqrt{2}/2$ the integrand becomes infinite.

A similar solution was also offered by Charles W. Trigg, Los Angeles.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below.

1550. *Cecil Leith, Scituate, H.S., Mass.*

1550. *Helen Bloodworth, Wesleyan College, Macon, Ga.*

1551. *Helen Bloodworth, Wesleyan College, Macon, Ga.*

PROBLEMS FOR SOLUTION

1568. *Proposed by Cecil B. Read, University of Wichita, Kansas.*

Solve for x:

$$1+x^4=a(1+x)^4.$$

1569. *Proposed by an algebra student.*

Solve for x:

$$\sqrt{x-\frac{1}{x}}+\sqrt{1-\frac{1}{x}}=\frac{x-1}{x}.$$

1570. *Proposed by Walter R. Warne, New York.*

If the base of a triangle AB is given and the opposite angle C, find the maximum value of $AC+BC$.

1571. *Proposed by Thomas A. Pickett, South Weymouth, Mass.*

Three towers, A, B, and C are situated at equal distances from each other on the circular walls enclosing a city. An outlying hill is 3 miles from A, 5 from B, and 7 from C. What is the diameter of the circle?

1572. *Proposed by L. Ahmad Husain, Lucknow, India.*

Given an angle XOY and a point, P on the bisector of the angle; Draw a straight line CPD terminated by the sides in C and D, having a given length K.

1573. *Proposed by Edward C. Varnum, Clyde, Ohio.*

In 1800 a man left a fund for three charities which was to be made available when the second charity has the greatest amount. The first char-

ity receives a dollar at 6% compounded annually, the second gets one dollar the first year, two dollars the second year, three dollars the third year, etc., and the third charity is to have $1232 at 6% simple interest. When will the charities receive their money?

SCIENCE QUESTIONS

October, 1938

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

DO YOU KNOW THE ANSWERS?

1. How cows sleep?
   (*Science Question No. 833. April, 1938.*)
2. Why you cannot make a tennis racquet rotate over and over without rotating also about its long axis (turns over)?
   (*Science Question No. 827. February, 1938.*)
3. How to use a "rain gauge"?
   (*Science Question No. 830. March, 1938.*)
4. How to interest your community in your School Affairs?
   (*Science Question No. 832, May, 1938*)
5. How many horses were used to separate the Magdeburg hemispheres?
   (*Science Question No. 818, May, 1938*)
6. How long is an American inch?
   (*Science Question No. 840, May, 1938.*)
7. How to make ice that sinks?
   (*Science Question No. 838, April, 1938.*)
8. What is the fastest living creature?
   (*Science Question No. 839, June, 1938.*)
9. What you did with that examination paper you were going to send to the EDITOR?
   (*Science Questions. October, 1938.*)
10. How to get into the GQRA?

Readers of SCHOOL SCIENCE AND MATHEMATICS *are asked to contribute: Questions, Answers, Comments, Suggestions—Whatever is new or interesting in the teaching of Science.*

Your classes and yourself are invited to join the GQRA (Guild Question Raisers and Answerers). More than 250 others have already been admitted to membership by answering a question or proposing one that is published.

EXAMINATIONS AND TESTS

What test paper did you use at the close of the semester just finished? Please send a copy to Jones, EDITOR, SCIENCE QUESTIONS, 10109 Wilbur Avenue, Cleveland, Ohio.

Send it in. Join the GQRA

GQRA—NEW MEMBERS—OCTOBER, 1938

236. Lester Dawson, Instructor in Mathematics, University of Alaska, College, Alaska.
237. Marie Boutuiller, Mercy Bio-ite Club, Mercy High School, Milwaukee, Wisconsin.

The following all from the Mercy Bio-ite Club:—

238. Anna Britz
239. Loretta Buskiewicz
240. LaVern Fleck
241. Dorothy Grabarczyk
242. Gertrude Kurlinski
243. Beatrice Laur
244. Frances McCosker
245. Geraldine Olson
246. Helen Raskiewicz
247. Janet Wiese
248. Kathryn Wissing
249. Jacqueline Wolosczyk.

250. John Kilpatrick, Stephen F. Austin College, Nacogdoches, Texas.
251. Daniel Holland, Wilson Junior College, Chicago, Ill.

FARTHEST NORTH PHOTOGRAPHY

844. *Proposed by Lester Dawson (Elected to the GQRA No. 236), Instructor in Mathematics, University of Alaska, College, Alaska.*

"Enclosed please find the examination questions given to our students in *Elementary Photography*. You may wish to publish these questions in SCHOOL SCIENCE AND MATHEMATICS.

The students in the Farthest North University in the world really are interested in photography as well as mining, the natural sciences, agriculture, civil engineering, hunting, skiing, basketball, etc."

FINAL EXAMINATION—PHOTOGRAPHY MAY 10, 1938

1. What is meant by good composition in a picture?
2. Name three factors that should be considered before taking a picture.
3. From the lens formula $(1/p)+(1/p')=(1/f)$, find the focal length "f" of a camera lens, given that $p=6.0''$, $p'=8.0''$.
4. Explain the meaning of a shutter opening of f 11.
5. Name two light sensitive materials.
6. Briefly describe the structure of unexposed film.
7. What is a developer?
8. Name two chemicals that develop.
9. What happens when silver bromide is exposed to light, then placed in a developer?
10. Give correct conditions of time and temperature in developing a roll of film.
11. Which is better, a strong or a weak developer? Why?
12. Define: contrast of a negative.
13. What is "hypo?"
14. Give two constituents of the hypo solution, stating the purpose of each.
15. If ugly brown spots appear on a contact print, what is the matter?
16. Give correct time and temperature for fixing a print.
17. Why should the wash water be cool, rather than hot?
18. What solution is used to test to determine whether the prints are washed free of hypo?
19. How does one avoid water spots appearing on the negative?
20. How may thin, over-developed negatives be correctly finished?

21. Why is a fine grained developer used for enlarging?
22. How is the correct time of exposure determined in making an enlargement?
23. In sepia toning, what happens when the black and white image is changed to a brown and white image?
24. What causes "fog" on a negative?
25. State how you think the course could be improved.

"A" students must also answer the following questions:

26. Explain meaning of depth of focus.
27. How would a picture taken at *f* 6.3 (time 1/50 sec.) compare with one taken at *f* 16 (time 1/25 sec.) in respect to
    a) sharpness of focus,
    b) depth of focus?
28. Name some lens used for camers, giving the advantages or disadvantages of each.

ALTERNATING OR PULSATING CURRENT

845. *Proposed by John Kilpatrick, Stephen F. Austin College, Nacogdoches, Texas. (Elected to the GQRA No. 250.)*

"For a long time we have been arguing over a question, neither side of which either of us can either prove or disprove to the satisfaction of both. Perhaps you or some of your readers can help us with the solution."

The question is: "In an induction coil whose primary is driven by a direct-current source (being interrupted, of course), is the voltage developed across the secondary alternating or pulsating current?" One of us maintains that it must be pulsating direct-current since it is necessary to connect an X-ray tube in one direction only to a large spark coil in the lab here, while the other can demonstrate on paper that the coil produces alternating current. By other indications, the one can show manifestations of direct current, while the other can prove theoretically that only alternating current can be produced by such a coil.

Please, somebody, set us straight on this matter so we can stop arguing.

DOPPLER EFFECT

846. *Proposed by Daniel Holland, Wilson Junior College, Chicago, Ill. (Elected to the GQRA No. 251.)*

Problem:—A whistle produces a pitch having 1000 vibrations per second. The velocity of sound at the time is 1200 feet per second.

Discuss the effect: (1) if the observer approaches the whistle at a velocity of 60 feet per second. and (2) if the whistle approaches the observer at a velocity of 60 feet per second.

What is New and Interesting?

BROADCAST FROM SHIP

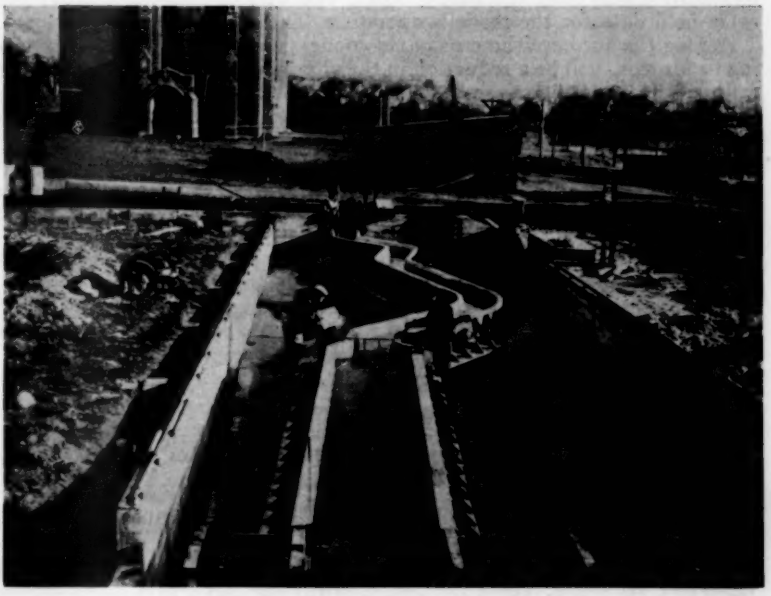
The Australian interstate motor-liner, the "Kanimbla," is the only vessel in the world that carries a complete broadcasting station. Miss Eileen M. Foley, announcer in charge, prints the station's programs early in advance, so as to accommodate listeners in other parts of the world. The call letters are 9MI.

MINIATURE MODELS FACILITATE FLOOD CONTROL STUDY

A WPA Project

A miniature river channel, built exactly to scale and including every twist and turn of the original stream has been built at the University of Washington in Seattle to provide a life-like laboratory for engineering students and to aid in testing and if possible improving flood control devices to protect Tacoma from the surging waters of the Puyallup river in flood time.

This model will supply a much needed facility for engineering students at the University, according to C. W. Harris, professor of Hydraulic Engineering at that institution. Mr. Harris asserts that students in all branches of engineering make a study of the movement of rivers and flood control. This is particularly true, he says, of students taking courses in Civil Engineering.



A model of three miles of the Puyallup River, scaled to 80 feet, has been installed at the rear of the hydraulic laboratory on the campus of the Univerity of Washington at Tacoma, Wash.

The model is 80 feet in length and represents the three miles of channel that courses through the city of Tacoma. One foot on the model represents 200 feet of the actual river. The exact action of the river is simulated in this miniature reproduction and in a surprisingly short time the engineers can gain an impression of the action of the river over the course of an entire year.

A pumping plant has been constructed to supply the water required for the operation of the "river." This plant, built by the University at a cost of some $4,000 makes available 15,000 gallons of water per minute, ac-

curately measured and entirely under control at all times. The flow of water must follow the same relationship as the flow of the natural river; hence it is necessary that the control device permit a miniature flow at both low and flood tide.

The flow of water through the miniature river would be of minimum benefit without means to study the silt movement in the Puyallup. To make this possible a sand mixture is supplied at the intake to enable the engineers to measure the formation of bars and spits as well as general erosion on a small scale.

In addition to the Corps of Army Engineers, a number of other agencies cooperated in making the possible flood control model. The Civil Engineering Department of the University of Washington sponsored the project and furnished the necessary pumping material and supplies. The State Department of Conservation and Development is supplying the supervisor, William Morton, Jr., who is a research engineer with the Department and who has had a number of years experience in flood control, reclamation and river and harbor work. The City of Tacoma is providing extra field data for the model's operation. The model is a WPA project.

Among the accomplishments of the model flood control project, according to Morton, will be a reduction in the alterations cost estimates for four railroad bridges which span the Puyallup. The bridges, of course, are reproduced on the miniature stream and under simulated conditions the effect of flood waters on them has been studied.

Preliminary estimates by the Corps of Army Engineers indicated a total cost of operations of $580,000. Data obtained from studies of the model will, according to conservative estimates, reduce this amount more than half.

The general research program, in addition to furnishing needed laboratory facilities for the engineering students, is to check and, if possible, aid the preliminary plans of the Corps of Army Engineers for flood control. Problems of silting and erosion and tidal and current movements will be carefully studied by means of the models.

BOOKS RECEIVED

Plane Geometry, by George T. Major, The Phillips Exeter Academy. Cloth. Pages xv+280. 12.5×19 cm. 1938. Charles Scribner's Sons, 579 Fifth Avenue, New York, N. Y.

Analytic Geometry, by Clyde E. Love, Professor of Mathematics, University of Michigan. Third Edition. Cloth. Pages xiv+279. 13.5×20 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.75.

Astronomy, A Textbook for University and College Students, by Robert H. Baker, Professor of Astronomy in the University of Illinois. Third Edition. Cloth. Pages x+527. 15×23 cm. 1938. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $3.75.

General Biology, A Textbook for College Students, by Perry D. Strausbaugh, Professor of Botany, West Virginia, and Bernal R. Weimer, Professor of Biology, Bethany College, West Virginia. Cloth. Pages xi+555. 14.5×23 cm. 1938. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $3.75.

Clear Thinking: An Approach Through Plane Geometry, by Leroy H. Schnell, State Teachers College, Indiana, Pennsylvania, and Mildred Crawford, Roosevelt School, Michigan State Normal Colegle, Ypsilanti,

Michigan. Cloth. Pages xviii+442. 13×20 cm. 1938. Harper and Brothers 49 East 33rd Street, New York, N. Y. Price $1.60.

Modern-School Geometry, by John R. Clark, The Lincoln School of Teachers College, Columbia University; Rolland R. Smith, Specialist in Mathematics, Public Schools, Springfield ,Massachusetts; in cooperation with Raleigh Schorling, Head of Department of Mathematics, The University High School and Professor of Education, University of Michigan. Cloth. Pages xiv+450. 12.5×20.5 cm. 1938. World Book Company, Yonkers-on-Hudson, New York. Price $1.36.

Solid Mensuration with Proofs, by Willis F. Kern, Assistant Professor of Mathematics at the U. S. Naval Academy, and James R. Bland, Assistant Professor of Mathematics at the U. S. Naval Academy. Second Edition. Cloth. Pages vii+172. 14×21.5 cm. 1938. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $2.00.

Survey of Physical Science, by Paul McCorkle, Professor of Physics and Physical Science, State Teachers College, West Chester, Pennsylvania. Cloth. Pages xiii+471. 14.5×21.5 cm. 1938. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $2.75.

High School Chemistry, by George Howard Bruce, Department of Chemistry, Horace Mann School for Boys, Teachers College, Columbia University. Second Revision. Cloth. Pages x+550. 13×19 cm. 1938. World Book Company, Yonkers-on-Hudson, New York, N. Y. Price $1.68.

Mathematics, General Course, by Arthur E. Newton, Superintendent of Schools, Baldwin, Long Island, New York, and formerly Head of Mathematics Department, Utica Free Academy, Utica, New York. Cloth. Pages viii+462. 12×18 cm. 1938. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $1.36.

Chemistry at Work, by William McPherson and William Edwards Henderson, both Professors of Chemistry in The Ohio State University; and George Winegar Fowler, Supervisor of Science, City Schools, Syracuse, New York, and Instructor in the Methods of Teaching Science, School of Education, Syracuse University. Cloth. Pages x+672. 14×22.5 cm. 1938. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $1.80.

An Introduction to Riemannian Geometry and the Tensor Calculus, by C. E. Weatherburn, Professor of Mathematics in the University of Western Australia. Cloth. Pages x+191. 13.5×21.5 cm. 1938. Cambridge University Press, London or The Macmillan Company, N. Y. Price $3.75.

A Textbook of General Botany for Colleges and Universities, by Richard M. Holman, Late Associate Professor of Botany in the College of Letters and Science of the University of California, and Wilfred W. Robbins, Professor of Botany in the College of Agriculture of the University of California. Fourth Edition. Cloth. Pages xvii+664. 15×23 cm. 1938. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $4.00.

Advanced Analytic Ceometry, by Alan D. Campbell, Professor of Mathematics, Syracuse University. Cloth. Pages x+310. 14×21.5 cm. 1938. John Wiley and Sons, 440 Fourth Avenue, New York, N. Y. Price $4.00.

Starcraft, by William H. Barton, Jr., Executive Curator, Hayden Planetarium, New York City, and Joseph Maron Joseph, Head, Science Department, Smedley Junior High School, Chester, Pennsylvania. Cloth. Pages vii+288. 15×23 cm. 1938. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $2.50.

Introduction to College Physics, by Clinton Maury Kilby, Professor of Physics in Randolph-Macon Woman's College, Lynchburg, Virginia. Second Edition. Cloth. Pages ix+398. 13.5×21.5 cm. 1938. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $3.25.

Skyways, by Charles Gilbert Hall. Cloth. 141 pages. 15×23.5 cm. 1938.

The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.32.

The Mail Comes Through, by Charles Gilbert Hall. Cloth. 135 pages. 15×23.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.32.

The Evolution of Physics, by Albert Einstein and Leopold Infeld, both Professors at the Institute for Advanced Study in Princeton, New Jersey. Cloth. Pages x+319. 13×20 cm. 1938. Simon and Schuster, Inc., 386 Fourth Avenue, New York, N. Y. Price $2.50.

Introductory General Chemistry, by Stuart R. Brinkley, Associate Professor of Chemistry, Yale University. Revised Edition. Cloth. Pages x+731. 14×21.5 cm 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.50.

Introduction to College Mathematics, by M. A. Hill, Jr., and J. Burton Linker, University of North Carolina. Cloth. Pages xi+373+93. 15×23.5 cm. 1938. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price $2.40.

A Laboratory and Field Guide to Biology, by Samuel H. Williams, Professor of Zoölogy in the University of Pittsburgh and Associate Director of the University Lake Laboratory. Cloth. Pages xxv+130. 11×15.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.25.

Essentials of Biology, by W. H. D. Meier, Head of the Department of Biology, State Teachers College, Framingham, Massachusetts, and Louis Meier Shoemaker, Assistant Professor of Science, State Teachers College, Trenton, New Jersey. Cloth. Pages vii+725. 12.5×19.5 cm. 1938. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $1.80.

Teaching Arithmetic in the Elementary School, Volume II—Intermediate Grades, by Robert Lee Morton, Ohio University, Athens, Ohio. Cloth. Pages xii+538. 13.5×20.5 cm. 1938. Silver Burdett Company, 45 East 17th Street, New York, N. Y. Price $2.72.

Statistical Methods, by Frederick Cecil Mills, Professor of Economics and Statistics, Columbia University. Revised. Cloth. Pages xix+746. 13.5×21.5 cm. 1938. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price $3.75.

Intermediate Algebra, by W. E. Brooke, Head of the Department of Mathematics and Mechanics, and H. B. Wilcox, Professor of Mechanics, Institute of Technology, University of Minnesota. Cloth. Pages viii+323. 13.5×20.5 cm. 1938. Farrar and Rinehart, Inc., New York, N. Y. Price $1.90.

A Short Course in Trigonometry, by James G. Hardy, Professor of Mathematics in Williams College. Revised Edition. Cloth. Pages ix+152+xvi +142. 13.5×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.25.

Mineral Tables, by Arthur S. Eakle, Late Professor of Mineralogy, University of California. Third Edition. Revised by Adolf Pabst, Associate Professor of Mineralogy, University of California. Cloth. 73 pages. 14.5×23 cm. 1938. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $1.50.

New Introduction to Biology, by Alfred C. Kinsey, Professor of Zoölogy Indiana University. Revised. Cloth. Pages xv+845. 13×19.5 cm. 1938. J. B. Lippincott Company, 220 No. Michigan Avenue, Chicago, Ill. Price $1.76.

An Orientation in Science, by Ten Members of the University of Rochester Faculty. C. W. Watkeys, Chief Editor. First Edition. Cloth. Pages x+560. 14.5×23 cm. 1938. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $3.50.

Science in General Education, A Report on the Committee on the Function of Science in General Education, Commission of Secondary School Curriculum, Progressive Education Association. V. T. Thayer, Chairman. Cloth. Pages xiii+591. 14×21.5 cm. 1938. D. Appleton-Century Company, 35 West 32nd Street, New York, N. Y. Price $3.00.

Demonstration Experiments in Physics, by Richard Manliffe Sutton, Associate Professor of Physics at Haverford College. Cloth. Pages viii+545. 15×23 cm. 1938. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $4.50.

Introductory Qualitative Analysis, by Warren C. Vosburgh, Professor of Chemistry at Duke University. Revised Edition. Cloth. Pages vii+222. 14×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.25.

The Importance of Certain Concepts and Laws of Logic for the Study and Teaching of Geometry, by Nathan Lazar. Cloth. 66 pages. 17.5×26 cm. 1938. *The Mathematics Teacher*, 525 W. 120th Street, New York, N. Y. Price $1.00.

Children of the Golden Queen, by Flora McIntyre. Cloth. 80 pages. 19×23 cm. 1938. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York, N. Y. Price $1.50.

Lasius the Lucky Ant, by Nina A. Frey. Cloth. 95 pages. 15×21.5 cm. 1938. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York, N. Y. Price $1.50.

The Nature of Proof, by Harold P. Fawcett. Cloth. Pages xi+146. 14.5×23 cm. 1938. Bureau of Publications, Teachers College, Columbia University, 525 West 120th Street, New York, N. Y.

An Introduction to Chemistry, by John C. Hogg, Chairman of the Department of Science, The Phillips Exeter Academy. Cloth. Pages xiv+365.14×21.5 cm. 1938. Oxford University Press, 114 Fifth Avenue, New York, N. Y. Price $2.00.

Introduction to the Theory of Equations, by Louis Weisner, Associate Professor of Mathematics, Hunter College of the City of New York. Cloth. Pages ix+188. 14×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.25.

A Hundred Years of Astronomy, by Reginald L. Waterfield. Cloth. 526 pages. 13.5×21 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $5.75.

Radio, A Study of First Principles, by Elmer E. Burns, Instructor in Physics, Austin High School, Chicago. Third Edition. Cloth. Pages xvi+293. 13.5×20 cm. 1938. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.00.

Descriptive Geometry, by Floyd A. Smutz, Professor of Engineering Drawing and Descriptive Geometry, Kansas State College of Agriculture and Applied Science, and Randolph F. Gingrich, Associate Professor of Machine Design, Kansas State College of Agriculture and Applied Science. Second Edition. Cloth. Pages x+227. 15×23 cm. 1938. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.50.

A Preface to Mathematics, by C. E. Van Horn, Professor of Mathematics, Fisk University. Cloth. Pages xii+124. 13×20 cm. 1938. Chapman and Grimes, Inc., 110 Mount Vernon Street, Boston, Mass.

Laboratory Experiments in Elementary Physics to Accompany Black and Davis' Elementary Practical Physics, by Newton Henry Black, Assistant Professor of Physics, Harvard University. Cloth. Pages xiii+263. 13.5×20.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.24.

The Progress Arithmetics, Book F, by Philip A. Boyer, Director, Division

of Educational Research, Philadelphia Public Schools; W. Walker Cheyney, Elementary Research Supervisor, Philadelphia Public Schools; and Holman White, Superintendent, District 9, Philadelphia Public Schools. Paper. 185 pages. 20.5×28 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 48 cents.

Manual for Comparative Anatomy, by Leonard P. Sayles, Assistant Professor of Biology, College of the City of New York. Cardboard. Pages xi+214. 18×25.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.60.

General Science Workbook, by Gilbert H. Trafton, Department of Biology, State Teachers College, Mankato, Minnesota, and Victor C. Smith, Department of General Science, Ramsey Junior High School, Minneapolis, Minnesota. Paper. 309 pages. 19×25.5 cm. 1938. J. B. Lippincott Company, 220 North Michigan Avenue, Chicago, Ill. Price $1.00.

Linear and Quadratic Equations, 1550–1660, by Sister Mary Thomas à Kempis Kloyda of the Sisters of Saint Francis, Rochester, Minnesota. Paper. xii+141. 21×27.5 cm. 1938. Edwards Brothers, Inc., Ann Arbor, Michigan.

BOOK REVIEWS

The Evolution of Physics, by Albert Einstein and Leopold Infeld, both at the Institute for Advanced Study in Princeton, New Jersey. Cloth. Pages x+319. 13.5×20 cm. 1938. Simon and Schuster, Inc., 386 Fourth Avenue, New York, N. Y. Price $2.50.

This is a book simple enough to lead the educated layman through the elementary steps of classical physics with its satisfactory explanation of the phenomena attendant upon macroscopic bodies, and its failure to explain the phenomena of electromagnetism, photo-electricity, radiation, and the results of a number of isolated experiments and observations, to the more complete explanation offered by the theory of relativity and quantum physics. It is an ideal first approach for the student of general physics to the realm of modern physics. Without employing mathematical symbols and equations the authors have presented the outline of the structure of recent physical development. They recognize that "thought and ideas, not formulae, are the beginning of every physical theory."

Chapter I explains the mechanical view of the universe as set up by Galileo and Newton and its successful application in the kinetic theory of matter. Chapter II shows the difficulties encountered in attempting to extend the mechanical view to the realm of electricity and optics: It offered no explanation of the relation of an electric current and a magnetic needle. It did not show why the force between current and pole acted normal to a line connecting them instead of along the line as demanded by the mechanical view. It did not explain why this force depended on the velocity of the moving charge. It demanded unusual and contradicting properties of the ether. Chapter III explains the field theory and its success where the mechanical view failed. It develops the relativity theory and shows that Newtonian physics is a special case of the more general theory. Some unsolved problems are mentioned. Chapter IV is an explanation of the quantum theory as developed to the present time. The entire book emphasizes growth and expansion, the evolution of physical thought, an unfinished story. "Yet new, still more difficult problems arise which have not been definitely settled as yet. . . . Science is not and never will be a closed book. Every important advance brings new questions. Every development reveals, in the long run, new and deeper difficulties."

G. W. W.

Essentials of Engineering Mathematics, by J. P. Ballatine, Ph.D., University of Washington, Seattle, Washington. Cloth. Pages xi+502+76. 15×23 cm. 1938. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $3.75.

This is one of a number of books on elementary mathematical analysis that have appeared in recent years. The unified type of treatment based on the function concept and in which the elements of the calculus are used throughout the course to aid in the discussion of the topics found in the standard courses has much to commend it. In the first place there is a coherence which we do not find in the compartment treatment. Moreover, the student preparing for engineering or for science has need for the methods of the calculus early in his college course. In addition, many interesting problems which have no place in the standard courses are solved easily by the methods of the calculus. For this reason the course is greatly enriched.

In this book we find some special features which merit attention.

1. The principles of the calculus have been stated in a simple manner and, at the same time, precisely.
2. Considerable attention has been given to the matter of units along one or both axes.
3. Differentials are introduced simultaneously with the derivative.
4. The derivative of x^n (n an integer) is established by mathematical induction and then used to determine the coefficients of the binomial expansion.
5. There is a systematic treatment of the integrals of $\sin^m x$ and $\cos^n x$ for both positive and negative values of m and n.
6. There is a neat derivation of the rotation formulas.
7. There is an abundance of interesting applied problems.

J. M. KINNEY

The Queen of the Sciences, by E. T. Bell, Ph.D., Professor of Mathematics, California Institute of Technology. Cloth. 138 pages. 12.5×19.5 cm. 1938. G. E. Stechert and Company, 31 East 10th Street, New York, N. Y.

This book is a reprint from the edition of 1931. Many people who have been trying to secure copies in recent years will be delighted to know that it may now be obtained.

In this little volume of ten chapters Professor Bell discusses some of the fundamental concepts and problems in the field of mathematics. In a style that is simple and comprehensible to the intelligent layman he reviews the tremendous advances that have been made during the past century.

The book should appeal especially to teachers and students of mathematics and science who have not had extensive training in the graduate field. It should find a place in every high school and college library.

J. M. KINNEY

College Algebra, by William L. Hart, Professor of Mathematics, University of Minnesota. Revised Edition. Cloth. Pages viii+408+30. 15.5×19.5 cm. 1938. D. C. Heath and Company, 285 Columbus Avenue, Boston, Massachusetts. Price $2.24.

In this revised edition the author follows the general plan of his alternate edition of 1930. There is some rearrangement of the content. Problems, excepting those in the theoretical exercises, are new. Improvements arising from the experiences of teachers who have used the former editions are incorporated. Such new topics as semilogarithmic and logarithmic graph-

ing, the method of least squares for solving systems of linear equations, the notions of the arithmetic mean, the standard deviation, the coefficient of correlation, and the elements of curve fitting by the method of least squares, have been added.

J. M. KINNEY

Today's Geometry, by David Reichgott and Lee R. Spiller, both of The New Haven High School, New Haven, Conn. Cloth. Pages xvi+380. 2.5×16×23.5 cm. 1938. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $1.84.

A new approach is used, designed to convince the student that geometry touches his life constantly—at home, at play, and at work, through guiding him in discovering the principles of geometry just as he would meet them in everyday experience.

Each phase of the subject is integrated with the normal life of the present day student and much emphasis is placed upon practical applications. To assist the student the more readily to understand the book contains nearly two hundred photographs and more than four hundred drawings and illustrations.

Formal demonstration is kept at a minimum. No attempt is made to adhere to rigorous proof. There are more postulate assumptions and assumed theorems than in the traditional geometry; however, numerous exercises based on these theorems and postulates afford practice in logical development. The order of topics is based on facility of application rather than on the traditional arrangement. Historical and cultural sidelights, and explanations of methods applying to geometry in industry are found throughout the book.

JOSEPH J. URBANCEK

Plane Geometry and Its Reasoning, by Harry C. Barber, English High School, Boston, and Gertrude Hendrix, Eastern Illinois State Teachers College, Charleston, Illinois. Cloth. Pages x+310. 2.3×14×21 cm. 1937. Harcourt, Brace and Company, New York, N. Y. Price $2.00.

The authors claim that the innovations of their text have all been tested in the classroom and accepted only after repeated trials have demonstrated their value.

Briefly stated the important phases of the textbook catalogue as follows:

1. A revised and shorter list of theorems
2. Unusual emphasis on analysis and reasoning
3. Extended use of algebra and trigonometry as aids to the reasoning of geometry
4. The authors state that "A sound and teachable treatment" of the irrational number is presented
5. Adequate preparation for modern examinations
6. Courses adapted to three levels of ability

The text begins by showing what demonstration is and what part it plays in man's thinking. It attempts to develop habits of finding facts, weighing evidence, and reasoning to unprejudiced conclusions. It applies its reasoning not only to geometry but to nongeometric situations as well. Without laboring the point, the authors have sought to make the study of geometry develop in some measure the scientific habit of mind.

JOSEPH J. URBANCEK

Trigonometry, by A. R. Crathorne, Professor of Mathematics, University of Illinois and the late E. B. Lytle formerly Professor of Mathematics,

University of Illinois. (Revised Edition.) Pages ix+191 without tables; ix+191+xvi+95 with tables. 1938. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. $1.70 without tables, $2.00 with tables.

This text has been rewritten in accordance with the suggestions of teachers who used the first edition. The new edition has been revised with the purpose in mind of clarifying the subject. Many new figures have been added. The number of problems has been increased.

The text presents plane and spherical trigonometry in a straightforward manner. The text is so arranged that it may be used for a two or three semester hour course.

The acute angle is taken up first and then the general angle. Line representation and radian are introduced in chapter IV together with the graphs of the trigonometric functions. Inverse trigonometric functions are carefully and correctly explained. A chapter is devoted to complex numbers and hyperbolic functions. The text is definitely an improvement over the first edition and will undoubtedly prove popular.

JOHN J. CORLISS

Plane Trigonometry, by Arthur M. Harding, Professor of Mathematics, University of Arkansas and George W. Mullins, Professor of Mathematics, Barnard College, Columbia University. (Revised Edition.) Cloth. Pages vi+172. 1937. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.60.

The first edition of Harding and Mullins' *Plane Trigonometry* enjoyed a wide use hence this revised edition. The revised edition follows closely the first. Few changes have been made in the explanatory material. The principal changes consist of (1) the addition of a chapter on logarithms (2) the addition of many new problems (3) and the arrangement so that either the even or odd numbered exercises completely cover the course.

The treatment is clear, concise, and conservative. The line segment OP (r) i.e., the hypotenuse of the triangle of reference is always considered as positive. This causes trouble in polar coordinates and in the line representation of the trigonometric functions. Radian measure is introduced in chapter XI. Line representation of the functions is treated in chapter XII and the curves are there drawn using different units on the respective axes thus giving distorted pictures. In chapter XIII, the last, Inverse Trigonometric Functions are considered. The identities are not restricted to principal values. The formulas for the solution of oblique triangles are derived geometrically. Throughout the entire book an effort is made to connect trigonometry with geometry.

JOHN J. CORLISS

A Story of Water, by Augustus Pigman. Cloth. Pages xii+151. 12.5×19 cm. 1938. D. Appleton-Century Company, 35 West 32nd Street, New York, N. Y. Price $1.50.

This is a supplementary science reader for the intermediate grades. It tells of the sources and uses of water, starting with the crude life of cave dwellers and carrying the story through the lives of herdsmen, the ancient cities of Asia and the Nile basin, ancient Rome, medieval Paris, and modern New York. Interest in the wells, pumps, aqueducts, and turbines indicate the author's engineering training and experience.

G. W. W.

Elementary Experimental Chemistry, by John C. Hogg, M.C., M.A., Chairman Science Department, Phillips Exeter Academy and Charles L. Bickel, A.M., Ph.D. Instructor in Chemistry, Phillips Exeter Academy. First Edition. Pages xvi+288. 14.5×22×3 cm. Line drawings of apparatus. Cloth. 1937. Oxford University Press. New York. $2.00.

This laboratory manual is no tail to any dog. It was not written "to accompany" any text but is intended to supply an opportunity to students of elementary chemistry to use a semi-inductive approach to some of the more essential laws and theories and principles of chemistry. In this respect it is a manual after the reviewer's own heart. In many instances there is given before the directions a sufficient theoretical introduction so that the student can make an intelligent attack on the problem. The results of the experiment are not anticipated however.

Another merit of the manual is that relatively few topics have been attempted thus leaving time for an adequate treatment of each of these. There are three principal parts to the book and the first part contains principally quantitative experiments. These are excellently selected and presented. Included are determinations of Water of Hydration, Percentage Compositions, Simplest Formula Equivalent Weight of Magnesium and Density of Oxygen.

Part II contains mainly preparations and descriptive chemistry. Part III contains supplemental material with a wider variety of approach and while not required for a standard minimum course it offers much opportunity to keep the active, fast working student busy with worth-while work.

Teachers who have been thinking of trying to get better educational results from the laboratory work will do well to study this manual.

FRANK B. WADE

Exploring Biology, by Ella T. Smith, Instructor in Biology, Salem High School, Salem, Ohio. Cloth. Pages iii+696. 14.5×22 cm. Harcourt, Brace and Company, New York and Chicago. Price $1.84.

Exploring Biology is intended as a high school biology text for a year's course.

Subject matter: a unit-problem organization. Nine units divided into thirty-four problems. Each unit is built on a basic biologic principle viz: 1—the cell, 2—classification of living things, 3—the use of food and oxygen by living things, 4—the interdependence of living things, 5—the control of health, 6—reproduction, 7—heredity, 8—evolution, 9—behavior. The author's use of "control of health" as a "biologic principle" requires comment. It seems preferable to think of this as a "practice" based on biologic principles.

Method: each problem is stated as a question. A conclusion to each problem is prepared by the student. This checks the mastery of the problem. A mastery of the problems fixes the principle. A Herbartian approach.

Motivation: 1—Each problem is introduced by some dramatic episode picked from incidents in the history of biology.

2.—Exploratory questions accompany each problem based on past student inquiry.

Technical terms are defined as they appear and pronounced if necessary.

An interesting item in the organization of this book is the development of what the author calls a "cumulative dictionary of biological terms," built up as the terms appear in the course.

There is an abundance of the usual activities suggested throughout the

text such as: observations, experiments, demonstrations, field trips and reference reading.

The book is well illustrated with photographs and understandable diagrams. The mechanical features of the book have been well executed.

This text is well written. It is narrative in its discourse. A special likeable item about the context is the ease with which a student can acquire clear ideas from the printed page.

To the biology teacher of a philosophic cast the units on heredity and evolution are very interesting.

Exploring Biology is a challenge to the idea that biology is a sort of synthesis of botany, zoölogy and physiology. Biology teachers will do well to examine this new text.

A. G. ZANDER

Discovering Our World, A Course in Science for the Middle Grades, by Wilbur L. Beauchamp, Mary Melrose, and Glenn O. Blough. Book One. Cloth. Pages 288. 13×19 cm. 1937. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Ill. Price 88 cents.

These fundamental studies in science make quite a definite appeal to the innate curiosity of the child scientist. The text should be quite helpful to a teacher less familiar with the fields of science since the approach, procedure, and accomplishments are clearly outlined followed by a number of review questions to clinch the facts.

Each phase of scientific study is handled in a unit of its own with suggestions for experimentation, review questions and illustrated examples of the activities. An effort is made throughout the text to encourage scientific thinking and methods of procedures.

The material used is well within the environment of the elementary pupil and the problems which are used are of interest to children of that age. The illustrations (mainly colored) are ample and accurate. The print and quality of paper are suitable for the young child. Teachers should be impressed by the adequate glossary and teaching notes which are so generously included.

MARIE SHIELDS

A First Course in Physics for Colleges, by Robert Andrews Millikan, Director of the Norman Bridge Laboratory of Physics, Pasadena, California; Henry Gordon Gale, Professor of Physics in the University of Chicago; and Charles William Edwards, Professor of Physics in Duke University. Revised Edition. Cloth. Pages xiii+712+lxii. 13.5×21.5 cm. 1938. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $4.00.

While the composition of the most of this revision of a standard textbook remains unchanged, some very important alterations have been made. These changes include improvements in the chapters on Electrical Radiations and Radioactivity, rearrangement of the topics in the chapter on the Applications of Principles of Electricity in Motion, addition of new topics such as the neon and sodium vapor lamp, condenser microphone, moving coil microphone, loud speakers, sound motion pictures, etc. The lists of problems have been completely revised and improved; many new pictures and diagrams have been added. In many ways the text has been made more attractive and useful and has been brought into step with current developments in the science.

Some confusion may be produced in the mind of the student when he reads sections 662, 686, 687, and 688 because the author has used the term

"positive electron" for two different particles and states that " . . . the mass of every atom is simply the mass of the positive electrons contained within its nucleus." Also " . . . —into that still almost invisible nucleus there must be packed four positive and two negative electrons." When section 662 is assigned students should be referred to the later sections mentioned above for the more recent ideas of the structure of the nucleus.

G. W. W.

Through By Rail, 152 pages; *Skyways* 141 pages; *The Mail Comes Through*, 135 pages, by Charles Gilbert Hall. Colth. 15.5×23.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.32 each.

Mr. Hall has here given fascinating stories of the development of the great system of railways which serve our country, of the progress made in navigation of the air from the Montgolfiers in 1783 to Mollison in 1936, and of the work of the United States Post Office Department. While these books are intended for use as readers in the intermediate grades, they will also delight, entertain, and instruct adults in all walks of life. The author is a master story-teller. In a few words he is able to give all the conditions which stimulate progress; he enables the reader to participate in the demonstrations of new means of transportation; he makes one share the responsibilities of the postman, the pilot, and the engineer. These books are so attractive and entertaining that any one who reads one of them will search the library for other similar books.

G. W. W.

Aluminum, by Douglas B. Hobbs. Cloth. Pages viii+295.14.5×23 cm. 1938. The Bruce Publishing Company, 524–544 N. Milwaukee, Street, Milwaukee, Wisconsin. Price $3.00.

This book may be used profitably as a reference text for industrial arts students in the secondary schools. The first part of the book gives the history of the development of the aluminum industry, the physical and chemical properties of aluminum, the manufacturing processes such as casting, machining, joining, and finishing. Directions for carrying out these processes are given in brief form but in sufficient detail to enable a shop student to succeed. There is also an interesting chapter on applications of aluminum and its alloys. The second part of the book describes twenty-five projects such as book ends, picture frames, lamps, etc., with complete instructions for their construction and a bill of materials for each. This section is a shop manual of great value for the home or school shop.

G. W. W.

American Wings, Modern Aviation for Everyone, by Captain Burr Leyson. Cloth. 214 pages. 14×20.5 cm. 1938. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York, N. Y. Price $2.00.

For the young man contemplating aviation as a vocation and for the general reader who wants to know about aviation and the work of those engaged in the industry in the United States, *American Wings* supplies the answer to many of the questions. It is written in story form and gives a view of aviation in all its military and civil uses. All the various types of planes are described in non-technical language. The history of the rapid development of aviation is given and a view of the probable future expansion and improvement. In several chapters the author takes the reader over typical or actual flights, including a pioneer mail trip, a training flight in a bomber, and a modern night trip in a giant airliner. The work of the

ground crews, the engineers, testing, radio department, airplane carriers for the navy, and in fact everything connected with the aviation industry is briefly discussed. Full-page photographs of many types of planes are included.

G. W. W.

High School Biology, by Ralph C. Benedict, Professor of Biology in Brooklyn College; Warren W. Knox, Acting Director, Division of Inspection and Examinations in the New York State Department of Education; and George K. Stone, Instructor in Biology, Junior-Senior High School, Hicksville, Long Island. Cloth. Pages xi+724. 13.5×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.00.

In the preface the authors state that this book "was planned for large groups of secondary-school pupils of average ability and above." Nothing is said as to what should be done with the large number of pupils of lower than average ability. Undoubtedly some of the material in the book, important and well presented as it is, is not for the latter group. Perhaps the authors would agree to the assignment of certain of the more technical sections to the better students only.

Another aim of the book, with which all teachers will probably agree, is the placing of emphasis upon biologic principles, with an effort "to develop and apply principles and generalizations in such a way that pupils will respect and habitually use the scientific method."

In general the text shows careful composition, with only such minor slips as are common in the first editions of general works of this type. The statement on page 54 that "in almost any section of our country it is possible to find from ten to fifteen species [of oaks] without much trouble" disregards some rather larger sections in the west and north. On page 547 it is stated that Mendel worked with peas for eleven years, whereas in his own paper Mendel mentions eight years. One slip of somewhat greater importance occurs on page 569 where in a discussion of radish-cabbage hybrids it is stated that the progeny of such hybrids are either straight cabbage or radish. According to Dobzhansky, in *Genetics and the Origin of Species*, 1937, such hybrids are tetraploid compounds of the two species having distinctive morphological characters entitling them to be regarded as constituting a new synthetic species.

There are forty chapters grouped into nine units titled as follows:

I. Man is one of millions of kinds of living things
II. There is unity among all living things
III. Living things and their environment are ever changing
IV. All living things have the same problems
V. Nutritional relationships establish a balance in nature
VI. Living things relate themselves to their environment
VII. Reproduction is race preservation
VIII. Reproduction is the basis of race changes
IX. Human progress is a biological phenomenon

The reviewer confessed to a preference for shorter unit titles, but on this question he recognizes that there is still much disagreement among teachers and text book writers in biology.

At the end of each chapter there is a list of "Review and Thought Questions" and a list of "Activities" or projects. There is a short bibliography of reference books. The index is well arranged and apparently complete. The book is abundantly illustrated with drawings and half-tones. Most of the former are either original or redrawn; the photographs are excellent

and well chosen. There are four beautiful color plates. The binding and typography are well done.

The reviewer recommends this book for careful examination by teachers of high school biology.

EDWARD C. COLIN

MUNDELEIN COLLEGE PENDULUM

In an unoccupied elevator shaft at Mundelein College for Women, Chicago, a Foucault pendulum is being installed, by which rotation of the earth on its axis may be demonstrated and measured. Swinging nine stories, the pendulum is 120 feet long, the longest of its kind in existence and the only one of its kind, so far as is known, to have its movements recorded by an electric spark. A smaller pendulum is installed in the Adler Planetarium.

The pendulum, which will be used by the physics department, will be valuable also to specialists in geophysics and astronomy and to other scientists and teachers, for whose use it will be available, since it will keep a permanent record of the value of the gravitational constant for the Chicago area.

Records of the precession of the earth as it turns under the bob of the pendulum will be made by means of an electric spark. The constant apparent deviation of the bob in the clockwise direction will make visible the actual precession of the earth under it in counter-clockwise direction, because of the rotation of the earth on its axis from east to west.

The location of the pendulum is especially desirable since the shaft can be kept closed and free of air draughts which would otherwise affect its motion.

The suspension, which is attached to the ceiling of the eighth floor of the skyscraper building, consists of two cylinders at right angles rolling on flat surfaces. It is a device credited to Alaeine Cummings Longdon, of Knox college. The pendulum ball, which swings in the pit 120 feet below the supsension, is supported by wires from the upper cylinder. The contact surfaces are hardened, and polished, resulting in very low friction. The pendulum has a slightly greater length for swinging in one direction, for which compensation is made by a counterpoise.

The recording of the azimuth of the swing is by means of a spark discharge which punctures a coated paper disc, 8 inches in diameter, on a suitable table below the pendulum. The table holding the paper disc is made of hard rubber, 12 inches in diameter, supported by a tripod casting. A brass ring about 8.5 inches in diameter is inlaid in the top surface and is connected to a terminal below.

A high voltage transformer is connected between this terminal and the ground. Thus as the pendulum swings across the ring, a spark jumps between the ring and a platinum point on the ball. The coated paper on the ring is then marked by the spark flashing through it.

The transformer circuit is closed at intervals when records are desired, for a duration of one or more swings. The brass ring is graduated in degrees to read the angular position of the points on the coated paper.

A synchronous timing motor operating from 115 volts 60 cycle current operates a contacting device which closes a contact each half hour.

The phenomenon is explained by the Law of Inertia: A swinging pendulum bob is a body in motion and will under this law move in a straight line path unless there is some deviating force acting upon it. Its return swing will be along the same path and so continue to vibrate in the same place indefinitely so long as it swings undisturbed by any outside force.

The pendulum derives its name from Jean B. L. Foucault, French physicist who, in 1851, demonstrated the earth's rotation through the use of a long, heavy-bob pendulum suspended under the dome of the Panthéon in Paris.

(N.B. The head of the physics department, whose idea is responsible for the installation of the pendulum, will be glad to give additional details about it. Also, if desired, pictures of science students timing the swing with a stop watch or adjusting different parts of the apparatus may be arranged by calling Briargate 7161 or addressing, Physics Department, Mundelein College, Chicago.)

PORTFOLIO OF PORTRAITS OF EMINENT PHYSICISTS

A portfolio of portraits of twleve eminent non-living physicists is in preparation, to be published by the journal *Scripta Mathematica* with the editorial assistance of a committee representing *The American Physics Teacher*. The physicists whose portraits will be included are: Newton, Galileo, Huygens, Ampere, Fresnel, Faraday, Joule, Clausius, Maxwell, Gibbs, Hertz, and Rowland. Each portrait will be approximately 25×36 cm. and will appear in a separate folder along with a biographical sketch written by Professor Henry Crew. Since publication will not be undertaken unless there is evidence of some demand, those who are interested in having such a portfolio made available should send their orders immediately to *Scripta Mathematica*, Yeshiva College, New York City. The reduced pre-publication price is two dollars, payable upon delivery.

The committee for making the plans consisted of R. T. Birge, Henry Crew, W. F. Magie, Duane Roller, L. W. Taylor, E. C. Watson, and J. Ginsburg, Editor of *Scripta Mathematica*. The committee made no pretension of being able to determine the twelve most eminent physicists of all time, but tried to select physicists who were truly great and whose portraits are likely to be of interest to Americans. Account also had to be taken of the fact that authentic portraits are not avialable in some cases. Since the committee consulted a number of other physicists in this country, its selections give some indication of American opinion regarding great physicists. For this reason it is of interest to know that, from an original list of some 50 names, good agreement was obtained on a list of 20, which included, besides the 12 finally chosen: Archimedes, Boltzmann, Gilbert Helmholtz, Kelvin, Kirchhoff, Oersted, and Rutherford. Other names seriously considered by one or more members of the committee were Alhazen, Black, Carnot, Coulomb, Henry, Lorentz, Rayleigh, Roentgen, Volta, Rumford, Stevin, and Young.

GLASS CENTER

A history of the glass industry, from the most primitive days 4,000 years ago when glass was first made to the glass world of tomorrow, when glass fabrics will be an important and widely-used material, will be presented jointly by three of America's largest glass manufacturers at the New York World Fair of 1939.

Actual manufacturing processes by which bottles, containers, bulbs, windows and other articles are made by machine methods will be shown in the Fair's Glass Center. Taking part in the exhibit are the Corning Glass Works, Owens-Illinois Glass Company and the Pittsburgh Plate Glass Company.

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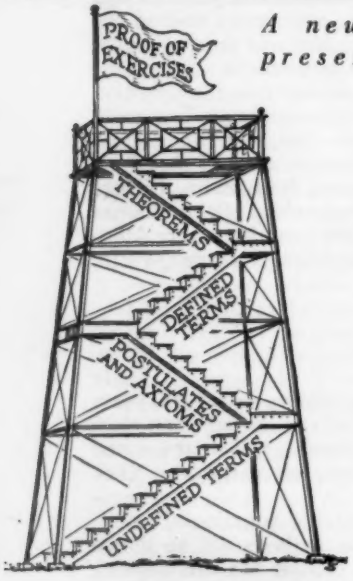

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